AGRICULTURAL ENGINEERING

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ASAE

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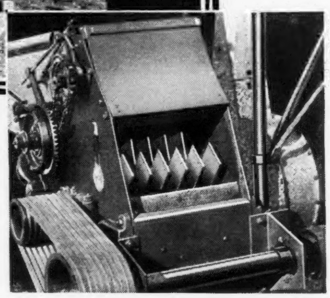

Two governors on the feeder. Straight, semi-rigid steel hammers, hardened and toughened for long service. Simple, durable and highly efficient.

Large blower fan, mounted on cylinder shaft. Air intake, wide pipes and long, easy curves keep feed passage open.

Speed jack. Multiple V-belt drive with nine rubber belts. Permits large pulley, eliminating slippage.

GRAIN and forage crops pay a much bigger return now when ground at home and fed to milk or meat producing animals. This fact is being brought home to farmers and feeders every day. With only high protein supplements to buy, the cash outlay for feed is greatly reduced.

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AGRICULTURAL ENGINEERING

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AGRICULTURAL ENGINEERING

Volume 12 NOVEMBER, 1931 Number 11

Present Trends in Dairy Management Methods and Structures[1]

By J. D. Long[2]

WE HUMANS are creatures of habit and tradition; our farm building designs give unmistakable proof of having developed slowly through generations of use. While the established customs usually have much to commend, changing labor conditions, changing customer demands, and the development of new equipment inject factors which may make old methods and structures obsolete, or of questionable economy.

Much of our present effort as agricultural engineers centers about dairy structures. Lowering the cost of production is being advocated as a safe and sure means of achieving "farm relief." In the dairy this means securing greater production per worker, putting forty cows in a milker's "string" instead of thirty, and so equipping the man and planning his routine that he will work at a high rate and without waste of time or duplication of effort. We must be concerned with the number of man-hours required for the production of 100 pounds of milk or care of one animal unit.

Another factor, the production of a clean, high quality product, has become a major item for consideration in our designs. It is questionable if, in striving to meet this requirement in the common stanchion barn where the cows are held for long periods, many of our designs have not trespassed in other considerations.

The requirements of sanitary milk production and the conditions necessary for the comfortable and hygienic housing of cows are in many respects antagonistic. The one demands impervious floors which are hard, usually cold, and frequently slippery; stanchions which, even though flexible, are confining and awkward; and narrow stalls which hamper movement and sometimes result in udder injuries from adjoining cows. Considering only the animal, freedom of movement is highly important, as indicated by the box stall comfort usually provided cows managed for high-production records. Ventilation can be more easily secured if the animals are free to adjust their position, the cows can be kept cleaner although somewhat more bedding is required, and considerable economies can be effected in the labor of cleaning and in initial structural investments. A recognition of these facts leads to dairy barn designs featuring separate milking room and housing quarters, which may develop into two separate structures.

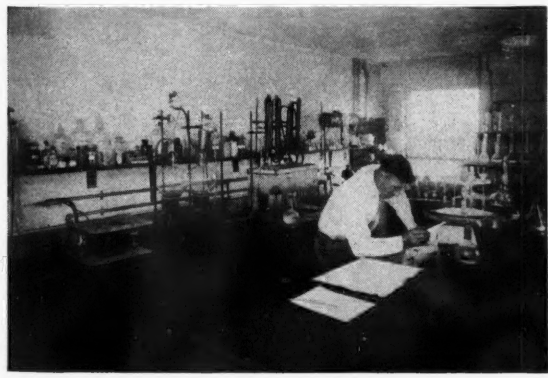
The development and use within the past year of the revolutionary rotary combine milking system (rotolactor) at the Walker-Gordon Farms in New Jersey has attracted considerable interest and not a little favorable reaction to this idea. While this particular design admittedly is not adaptable to general use certain of its principles have proven their practicability through years of use prior to the rotary development.

The Covered Yard. The first experimental work on running cows loose in a barn, confining them only for milking, was done apparently at the University of Illinois[3]. A preliminary survey of 18 dairy farms in the state where the method was in successful use showed that in some instances the cows were milked in the feeding barn and in others were taken into an adjoining stable for milking. In the first the cows were allowed to run loose, except at milking time, when they were confined in stanchions and fed concentrates. An example of the latter was on a farm where a three stall, "walk-through" stable was used for a herd of 33 cows. The general layout is shown in Fig. 1. This barn was recently reported as still in use, more than 25 years after the initial survey. Professor Fraser reiterates his belief in the "covered yard" and separate milking in his recent book, "Dairy Farming."

[1]Paper presented at the Structures Division session of the 25th annual meeting of the American Society of Agricultural Engineers, at Ames, Iowa, June 1931.

[2]Junior agricultural engineer, University of California, Davis, Calif. Mem. A.S.A.E.

[3]Should dairy cows be confined in stalls? W. J. Fraser, Illinois Agricultural Experiment Station Circular number 93. July 1905.



(Left) A view of the chemical laboratory, an important unit of the industrialized dairy enterprise at Brook Hill Farm in Wisconsin. (Right) A view of one of the stables

A few years after the work at the University of Illinois, Dr. S. S. Buckley and Mr. R. W. Lamson of the Maryland Agricultural Experiment Station ran a three-year comparative test of an open stable versus a closed stable of standard design. The open stable, floor plan shown in Fig. 2, had solid concrete walls 5 feet high with posts above supporting the roof, leaving the upper side wall an open space of 3½ feet entirely around the building except where the milking stable adjoined. Significant statements were made relative to temperature: "The experiences gained in the open and closed stable comparison indicate the evil effects of low temperatures have been greater over-estimated. . . . There is no instance in this experiment in which there has been a decided decrease in production of milk, temporary or permanent, which can be attributed to low temperatures or to sudden fluctuations in temperature, unless at the same time exposed to rain." Minimum temperatures in the open and closed stables were —14 degrees and +11 degrees, respectively. The advantages claimed for the open-stable method were[4] (1) economy of construction, (2) fewer stanchions and mangers, (3) economy of labor, (4) better manure, (5) cleaner cows, (6) greater comfort of cows, (7) slightly cheaper cost of feed in production of milk, and (8) production of milk of lower bacterial content.

On the other hand, "there have been only two disadvantages suggested against the use of the open stable, which it has not been possible to refute by the results of actual experience. One of these is the low temperature of the milking room in extreme weather in winter, ... and the second is the arrangement for feeding the roughages to the cows." Both of these criticisms may be obviated without greatly altering the design.

In a recent letter from Dr. H. J. Patterson, director, Maryland Agricultural Experiment Station, are the following comments:

"We still continue to use the open barn described in our Bulletin No. 177 for young stock, but have not used it for several years for cows in the manner described in the bulletin . . . . due to the fact it was not as well suited to some of the experimental work in hand as the other types of stables. This type of stable did not conform to the arbitrary regulations of city boards of health, and consequently it was not adopted to any extent by dairymen in our state. In the changes in personnel of our own staff I have found it difficult in the case of this barn, as with many other things, to overcome the prejudices which seem to be instilled in people according to the environment in which they were raised. . . . I believe that all of the points set forth by Dr. Buckley in favor of the open-type barn still hold true. . . . I feel quite certain that, if I had the planning and management of a practical and commercial herd, I would use some modification of the barn described in Bulletin No. 177."

Acceptance of the idea of separate structures for milking and feeding is general in Australia and New Zealand. The parallel, walk-through milking barn is in favor[5]. Fig. 3 shows a grouping of dairy farm buildings suggested for use in New South Wales.

For the past eight years the California Agricultural Experiment Station has been advocating the dual-structure system, and in various forms it is now widely accepted there. Due to the varying conditions of the state, climatic and otherwise, the dairies during past years have exhibited a hodge-podge of structural designs. A barn with central hay mow extending from the ground and sheds either side has been most widespread. When health authorities prohibited whole milk production in these barns the trend swung to one-story stanchion barns large enough to contain the entire herd at milking time. Concentrates were fed in the barn and roughages in the open corrals. The cows spent about six hours of the twenty-four in the barn during the two milking periods and the remainder of the time in the open, in the mud or hot sun of the feedlot.

Animal husbandry men believed this exposure detrimental to economical production, and tests and data secured from practical dairymen substantiate this view. Either the production dropped as the cows suffered exposure and required additional heat units to maintain their body temperature, or additional feed, amounting to 25 per cent more in some estimates, was required in order to maintain the production. Plans were then prepared for a combined feed and shelter barn, large enough for the entire herd with central hay mow and sheds on either side. The sides of the shed were left open to get sunlight and air into the shed. The eaves of the shed roof were brought as low as possible and the sheds were made 20 feet deep, including manger and feed alley, to prevent rain wetting much of the floor. A narrow strip of pavement along the length of the shed is being advised for winter corral use.

A paved, double lane leads from the shelter barn to the milking barn; one lane, 16 feet wide, is used as a holding corral (as well as a general service lane to the barn), and the second, 4 feet wide, as a return lane.

The Unit Milking Barn. The small, unit type of milking barn was the first recommendation. This has been, for the "one-man" herds, a single-row, twelve-stanchion barn with an attached milkhouse at one end and grain room at the other, as shown in Fig. 4. The cows are usually held in rigid wood stanchions and fed from a standard type concrete manger with the bottom raised 4 inches above the level of the standing platform. They are held in the barn about an hour to complete milking, if there is but the one milker; when released down the four-foot

[4]Open stables versus closed stables for dairy animals. S. S. Buckley. The bacterial content of milk produced in the open stable and in the closed stable. R. W. Lamson. Maryland Agricultural Experiment Station. Bulletin number 177. May 1913.

[5]Dairy farm buildings. L. T. MacInnes and A. Brooks. New South Wales Department of Agriculture. Farmers' Bulletin number 149. June 1924.

Fig. 1. Plan of a northern Illinois dairy barn in use for more than 25 years. Thirty-three cows are sheltered loose in the feeding barn. At milking time those on side "A" are moved to "B", the gates closed and the cows admitted to the three-stall milking room. When they have been milked, the cows go forward through the gate at the head of the stall and back to the feed barn "A". Part of the milking room space could be advantageously used as a grain room, or possibly as a milk room. ("Dairy Farming," Fraser.)

Fig. 2. Plans of an experimental barn used successfully for a time at the Maryland Agricultural Experiment Station. The side walls are solid to a height of 5 feet and then open 3½ feet to the ceiling. At milking time the cows are herded from "A" into "B" and then admitted a few at a time through the milking barn "C". (Maryland Agricultural Experiment Station Bulletin 177)

Fig. 3. An Australian plan of a dairy farm building's group, exclusive of the calf yard and bull paddock. The herd are held in the main receiving yard and bail yard, the latter of which is paved and preferably roofed, until they pass through the six-stall, walk-through milking barn. The cows are fed concentrates as they are being milked and roughages in a special feed barn after milking

Fig. 4. A unit barn of 12 stanchions in a row, with milk house at one end and grain room at the other. The herd is detained in a holding corral, put through the milking barn in groups and returned to the feed and shelter barn through a narrow lane. This number of stanchions is considered satisfactory for this method in herds not to exceed 48 cows. One unit or group of 12 cows an hour can be milked by one milker

Fig. 5. A six-stall "parallel walk-through" milking barn with attached milk house and grain room, an arrangement for hand or bucket milking. Cows enter the stall and feed on concentrates in boxes hung in the door at the head of the stall, pass out through the door when it is opened and down a lane to the feed barn or pasture. Five cows an hour pass through each stall. A small feed supply can be kept in the central space between each pair of stalls

Fig. 6. A 12-stall, parallel walk-through milking barn with attached milk house and grain room, arranged for a releaser type milking machine. Small "flags" hinged to the stall door frame signal the milk house operator when a cow has been released so he can place feed for the next cow

Fig. 7. A farmstead plan featuring a shelter and feed shed and a six-stall, parallel walk-through milking barn. Designed by the Golden State Milk Products Company for the consideration of their farmer-patrons

FIG. 1.

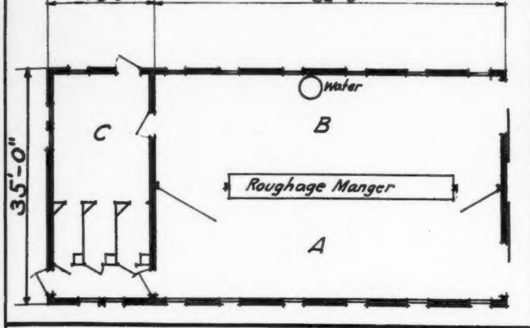


FIG. 2.

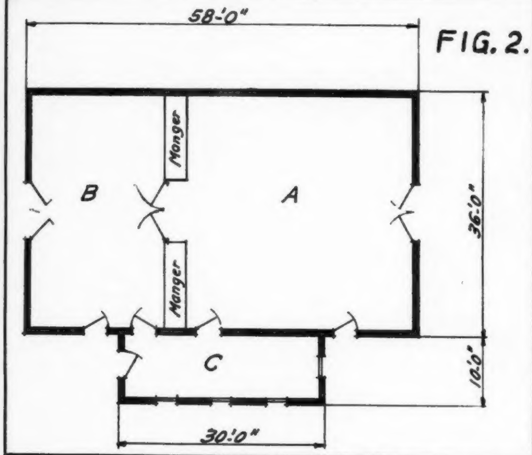
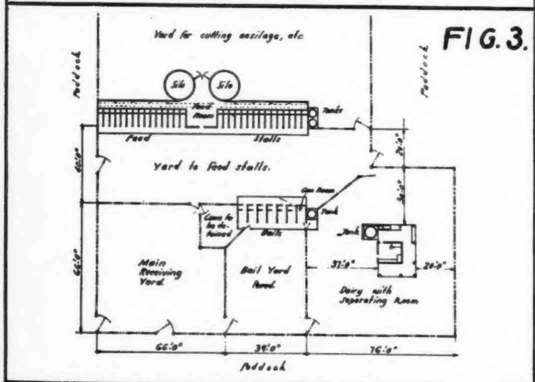


FIG. 3.



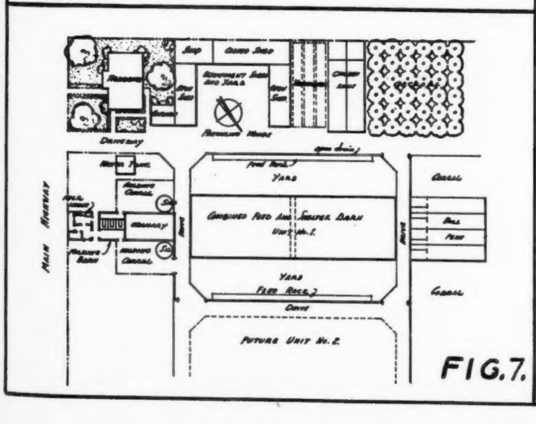


FIG. 7.

FIG. 4.

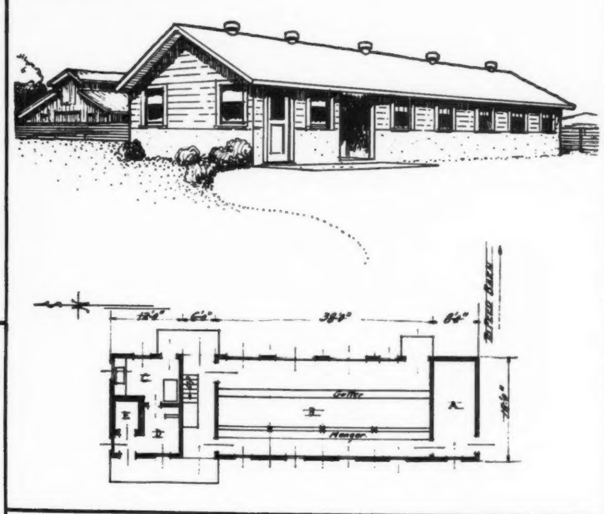


FIG. 5.

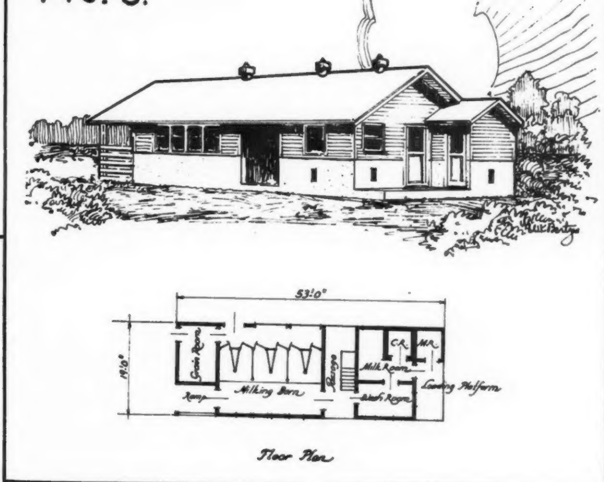
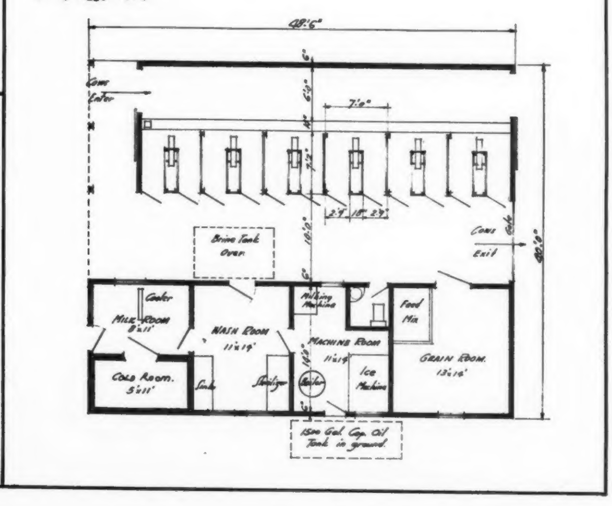


FIG. 6.



lane their places are taken by another group from the holding corral. The capacity of the barn has been arbitrarily taken as being three or four groups of cows, or as three or four times the number of stanchions. Dairymen, at first prejudiced in favor of a milking barn large enough for the entire herd, have found this number of group changes not impractical.

The investment in such a layout varies according to conditions, but at prices common in California for the past four years will have averaged about as follows at contract and standard commercial prices:

Milking barn (12 stanchions, attached granary and milk house, 18 by 64 feet)	$1700.00
Feed and shelter barn (36-cow milking herd, dry stock, calves, bull and team of horses, 80 tons loose hay, 60 by 80 feet)	2100.00
Fences and gates (approximately 900 feet corral fencing and 8 gates)	240.00
Paving (30-foot strip along sheds and 160-foot lane, 20 feet wide)	800.00
Equipment (milking machine, refrigeration machine, cold box, tubular cooler, wash sink and sterilizer)	1600.00
	$6440.00

Some larger milking barns have been built for larger herds, the 1-to-3 ratio of stanchions to number of cows being common, and one-two-row, twelve-stanchion barn is in successful use on a 30-cow dairy. The most attractive argument for the system is that it provides shelter for both the animals and roughages, and a sanitary milking barn for not more than was being invested in a milking barn large enough for the entire herd. Some extra labor is expended in handling the group of cows in the small barn, but this is offset by the added labor of cleaning the larger barn. There is the disadvantage in some climates of exposure while the cows are in the holding corral unless the lane is enclosed. In some parts of California dairymen have considered roofing over the lanes solely for shade, but as yet none have done so.

The Parallel Walk-Through Milking Barn. The so-called "walk-through" barn with parallel stalls has had an interesting history in California. It was introduced originally from New Zealand and Australia with the releaser type of milking machine. Because the original make of releaser milker caused mechanical difficulties, even to flavoring the milk, and had no facilities for production testing, the entire system was generally condemned for years. A few converts, however, have demonstrated that the structure can be used with hand or bucket milking, and successful releaser milkers are now being built.

In use the cows are admitted one at a time from the holding corral and find their way to a vacant stall. Until they are accustomed to the system the cows are held in the stalls by a chain passed behind them. In the door which forms the front wall of the stall there may be placed a feeding bucket, which may be filled from the feed alley, or by the milker from a small supply kept in the central space of each pair of stalls.

LABOR REQUIREMENT VARIATIONS

Twelve minutes are sufficient for the cow to eat her concentrates and the milking to be completed. An overhead lever permits the milker to open the stall door, the cow walks into a passage and out to the lane leading back to the feeding barn. (See Fig. 5.) Five cows an hour can pass through each stall without confusion. The cows in the larger herds are divided into groups and the individual cows of each group enter the barn in almost the same order, giving regularity to the milking time. The system is simplified in some installations by feeding the concentrates in the shelter barn either before or after milking, thus requiring but 6 to 8 minutes in the milking barn for each cow. This practice is being recommended in California.

There is considerable variation in the methods of milking. For the hand-milked herds from two to six stalls per milker are used, about ten cows per hour being turned out by each man. In one certified milk dairy, where the cows are fed just before entering the milking barn, three milkers easily put 191 cows through the barn in three hours using two single-unit, bucket machines per man. In a one-man barn nearby 20 cows are milked per hour with a double-unit, bucket machine. In a whole-milk dairy operated by a large milk products company a releaser type milking machine is in use, and one man is responsible for feeding roughages, breeding and milking a herd of 180 cows. At milking time he bring up the cows and operates the milking machine. He is assisted by two strippers and a fourth man who feeds the cows the concentrates ration and tends to the milk house work, the design of the building permitting this dual job to be accomplished easily (See Fig. 6.) In the winter a fifth man is required to wash the cows. At other times the four-man crew does all the work for the entire herd from the time the feeds are delivered to the barn until the ten gallon cans of milk are ready to be shipped out, except for cleaning the feed barn and corrals. Except for mishaps, four hours is the maximum time required for the crew per milking, one cow being milked per minute during the three-hour milking period and one hour allowed for cleaning up. The barn has been in service three years. The average bacterial count is 5000 to 6000.

These labor requirement variations are largely due to differences in the type of milking equipment. The advantages of the walk-through structural design over the standard stanchion and manger used in the "unit" barn of standard design lie in the somewhat lower structural investment and the efficient, "straight-line" handling of the cows, avoiding confusion and saving time.

Dr. J. J. Frey, field manager of the Golden State Milk Products Company, states the attention of his organization was first drawn to the walk-through barn and releaser milker combination when he visited a dairy using this equipment where one man was easily milking a 90-cow herd. At their own ranch at the time they were struggling to develop a system where one man with a standard barn and bucket machine could handle 60 cows.

After their 12-cow, walk-through barn previously described was erected and they had assembled their own releaser milker equipment, a labor cost comparison was made of the production in this and in their old 360-cow barn of standard design. The monthly labor cost of milking was $3.26 per cow in the first and $3.50 in the latter, showing a saving of 24 cents per cow per man for the walk-through, releaser milker equipment. This data was secured when the walk-through barn was being operated at low efficiency, the herd going through it numbering only 126 cows. The total capacity of the barn on a 24-hour operating basis is estimated by Dr. Frey at 540 cows being milked twice daily. The methods for capacity operation involve three shifts of milkers, each milking their herd of 180 cows twice daily and requiring four hours to complete each milking. Not a small part of the labor economy of the structure lies in the lessened cleaning. Not as much manure accumulates in the small time the cows are in the barn and there are but 5.6 square feet of floor area per cow to wash compared with 49.5 square feet per cow in the stanchion type barn. Another factor is that the milkers work at higher speed and with less lost motion.

On the basis of their experience the Golden State Milk Products Company is recommending to their producer patrons the erection of the walk-through design of barn. According to Dr. Frey this is done on the theory that "assisting their producers to save a dollar is equivalent to paying them a dollar more for their product." Plans for a complete layout of this type are provided farmer-patrons by the company. (See Fig. 7.) One contract cost of a six-stall milking barn of this type, 20 by 46 feet, including a concrete water trough in the corral and a tile drain, was $1150.00. In another instance where old barns were remodeled for feed and shelter barns, the erection cost of

a new 8-stall walk-through milking barn complete, milk house and equipment—cold room, tubular cooler, 1½-ton ice machine, brine tank and washing and sterilizing equipment—and concrete water trough and drains for a herd or 90 cows was $2640.00. The erection cost of the 12-cow barn of the Golden State Milk Products Company, including a cold box, milk room, washing room, machine room, lavatory and feed room—total, 1920 square feet—was approximately $2700.00. This was at the rate of $1.40 per square foot of floor area, or $5.00 per cow when used to capacity.

The Tandem Walk-Through Milking Barn. The tandem stall arrangement of the walk-through barn is just now coming into California. So far as the state agricultural experiment station is concerned it is still in the experimental stage.

In this design the cows are made to follow after one another in one or more files. In one system of this general method the cows are washed and fed outside and are merely held in a lane, one behind the other while they are being milked, one milker handling two to four cows. An interesting feature which is being suggested for this system is the placing of the milker on a level below that of the cows to minimize the stooping necessary. (See Fig. 8.) The cows are in the stalls four to six minutes.

Mr. Grover Meyer, of Leavenworth, Kansas, has used a somewhat similar system of his own design for the past three years, milking a herd numbering 80 to 100 cows and retailing "Grade A" raw milk. The milking barn and milk house are combined, the arrangement being similar to that shown in Fig. 9. The cows are admitted at one end and held two at a time in washing stalls. From these they go along an aisle against the outer wall and enter one of three milking stalls placed end to end. One of the new "combine" milking machines is now being used and massaging the udder practiced in lieu of stripping, but originally the cows were released from the milking stalls and held in a file, one behind the other for stripping. As precautions against flies in the milking room the cows in entering pass one at a time through a fly brush and trap device and in leaving force their way out of double doors mounted on spring hinges.

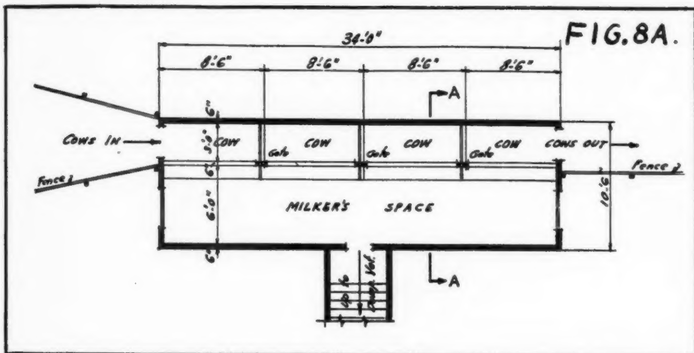
A second development of this method has the cows progress for each stage of their milking. The herd is

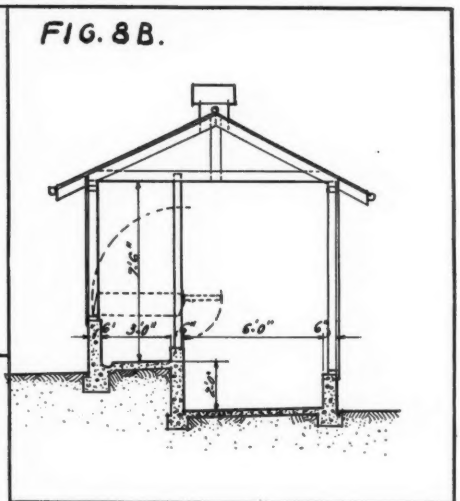
Fig. 8. Suggestion for a four-stall, "tandem walk-through" milking barn. No feeding is done as the cows are being milked. Cows remain in the stalls from four to six minutes. The floor level of the work alley is dropped 2 feet below the level of the cow platform so the milker does not have to stoop for milking

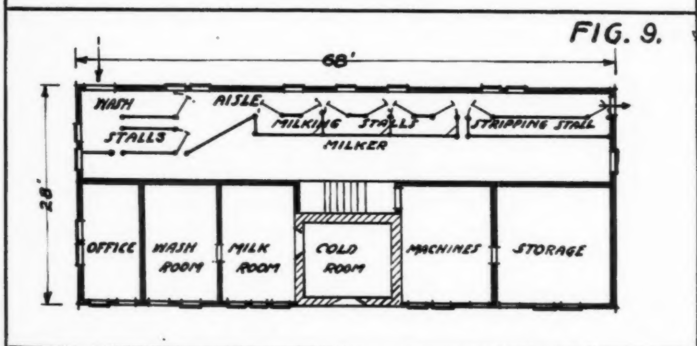
Fig. 9. A progressive, tandem walk-through milking barn similar to that designed and used by Grover Meyer, Leavenworth, Kansas

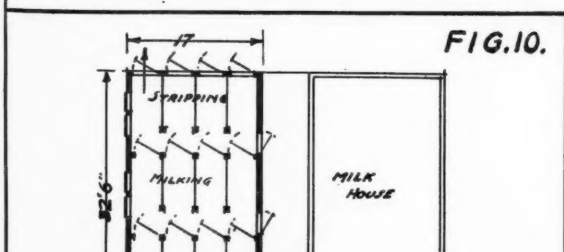
Fig. 10. A four-row, progressive, tandem walk-through milking barn

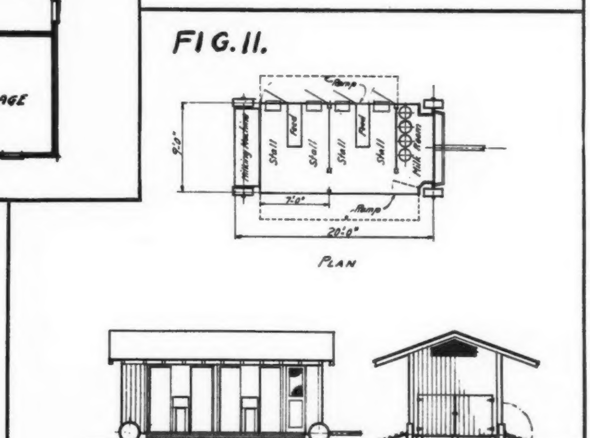
Fig. 11. Suggestion for a movable, walk-through milking barn for the renter or for use at various points in a pasture











admitted to the barn in one or more rows as shown in Fig. 10. The first cows entering in each find themselves in a compartment where they are washed. At the end of about five minutes the gate ahead of them opens for them to pass into the second compartment where they are milked and may be fed concentrates. From here they pass into a third compartment directly on ahead where they are stripped and released to return to the corral.

Advantages claimed for the tandem over the parallel walk-through barn are greater ease in training cows to the system and even less confusion of handling. It may also be possible to cut down still more on the initial structural investment required. The labor requirement would seem to be about the same as in the parallel walk-through system for similar types of milking machinery.

The Rotary Milking Platform. The rotary milking platform, or "rotolactor," as developed by the Walker-Gordon Farms in New Jersey has many distinctive features which merit approval. The mechanical responsibilities, operating costs and certain other characteristics naturally limit the usefulness of this system to a few of the largest dairy organizations.

The cows are stabled in a number of feed and shelter barns and move down a lane to a structure which houses offices, laboratories, milk rooms and a visitors' gallery as well as the milking system. The cows are admitted in single file and step upon a revolving platform carrying 50 stanchions facing toward the center. The platform makes a complete revolution in about 12½ minutes, during which time the cow has been washed and milked by a releaser milker which is then washed and sterilized. As the cow nears the end of the revolution and milking is completed, a passage way opens ahead of her which leads down a ramp, under the platform and back to the feed barn.

Portable Field Milking Barns. Another type of dairy management, which is bidding for attention and which involves different structural designs, is that wherein the herd is kept continuously on pasture and the buildings consisting of a portable walk-through barn, parallel stalls, and milk house are moved from place to place in the pasture as frequently as may be required by feed, water, and soil conditions. (See Fig. 11.) As might be expected, this method originated in England, probably as a descendant of the New Zealand and Australian methods, and is reported to have made a favorable impression in certain dairying districts of that country. The chief advantages claimed for the open-air system are decreased cost of production, both labor and equipment costs, improved pastures, and improved health of the herd.

ENGLISH SYSTEM RESULTS IN PENNSYLVANIA

Mr. R. L. Montgomery of Philadelphia, Pennsylvania, after considerable experience in running dairy stock in the open in eastern Pennsylvania, imported one of the English "bails" in 1928 and later purchased a second. His experiences of the first year's use with a herd of eighteen animals he sums up as follows:

"1. The health of the animals in the open was at least as good, I think better, than that of the animals in the stables.

"2. The amount of milk produced per animal was substantially less than that of those in the stables. . . . the largest factor in the decrease of production was probably lack of water, it being necessary for the animals to travel a considerable distance over frozen ground to reach the water supply.

"3. The amount of food consumed per animal was materially greater for those pastured in the open.

"4. The amount of hay consumed per animal was materially less for the pastured animals due to the fact they took advantage of the first bite of grass.

"5. In the early spring the milk of the open-air dairy was free from any noticeable taste of new grass or garlic.

"6. The labor necessary per animal is at least 50 per cent less in the open air system.

"7. The effect of moving the milking bail, and holding corral upon the pastures is excellent and approximately as described by the English manufacturer."

During his second year Mr. Montgomery increased the open-air herd to 55 cows. "The experiment was successful and I took care to remedy the lack of water noted the first winter. I am of the opinion that the cold weather cuts down the milk flow to some extent, also that this can be remedied by some additional feeding. The savings in labor costs, however, together with the savings in capital expenditures for buildings, more than offset any loss in production. A large saving resulted also in eliminating bedding. My experience shows that one cannot control the bacteria count quite as well as in a thoroughly modern barn, connected with a modern sterilization system. . . . I think, economically, the system is far in advance of anything now existing, providing it is used in connection with grass farming."

Independently of the English development, the Golden State Milk Products Company designed a portable milking structure and milk house of similar nature. It provided for four parallel, walk-through stalls on skids and had a sloped "checker plate" metal floor and an all metal superstructure. The idea was developed primarily for renter dairymen, but the advantages of the open-air pasture system on other farms were also considered. A cost estimate of $727.00 for the first structure has been given by one of the steel companies, but as yet none has been erected.

Experimental Data. Some Middle West farmers and equipment salesmen have questioned the advisability of running cows loose, believing confinement in stanchions necessary for cow cleanliness and temperature control. Others concede the point but believe the cows should be confined in pens in small groups.

The idea of portable field structures provides amusement for some but works successfully and economically for others. It is evident that agricultural engineers, animal husbandrymen and farm management specialists must face the situation with open minds and cooperate on controlled experiments seeking the facts.

At the 1931 convention of the American Dairy Science Association, Professor W. M. Regan of the California Agricultural Experiment Station reported the results of a test in which he placed two Jersey cows in a large psychrometric room for a period of 45 days, varying the temperature between 38 and 100 degrees F and the relative humidity between 20 and 90 per cent. The temperature changes proved more potent in their effect on the physical well-being of the cows and upon the amount and physicochemical characteristics of the milk produced than the humidity variations. Coincident with the high temperatures was a definite falling off in milk production, as much as 30 per cent in 5 days, a marked increase in the rate of respiration, and a significant rise in body temperature.

On the same program Professor J. R. Dice reported tentative conclusions on the work in progress at the North Dakota Agricultural College as follows:

1. Milk cows can withstand exposure to severe weather provided they have shelter equivalent to an open shed and are well fed.
2. Frosted teats, more prevalent with pendulous udders, is apparently the only factor that would handicap cows during the sub-zero weather.
3. The comfort and convenience of the caretaker and the requirements for the production of high quality milk rather than the need of the cows justify the use of stables such as are common today.
4. It is an axiom with shepherds that sheep can stand low temperatures provided they have access to shelter that is dry and free from drafts. We believe that this will apply equally well to dairy cows.
5. Apparently the emphasis now placed on the necessity for keeping cows in comfortable quarters should be placed squarely where it belongs—on the necessity of feeding the cows enough of the right kind of feed to maintain production during cold weather.

CONCLUSIONS

1. The design of dairy structures is dependent on management methods and the equipment used, as well as on type and quality of product.

2. Structural designs and management methods permitting maximum production per worker are necessary for economical production.

3. Separate milking and housing facilities have proven successful over a period of years and are increasingly popular. There would seem to be no reason why designs cannot be developed to meet any climatic conditions.

4. The chief advantages claimed for the two-unit system are:

(a) Increased animal comfort. Cow spends less time on hard floors and locked in stanchion. Can adjust position to drafts and winds.

(b) Greater convenience. Adaptable to hand or mechanical milking, bucket or releaser type. Herd size may vary within wide limits. Less distance for milker to walk, and a fractional part of the milking barn floor space per cow to be cleaned.

(c) Economy. More efficient use of equipment. Lower labor charges and savings of water and artificial lighting. Simplified milking machine installation. Lower initial cost of structures and equipment.

(d) Increased sanitation. Smaller areas to clean. Cows in milking barn a shorter time, less time for droppings. Droppings immediately flushed away. Ventilation difficulties minimized.

(e) Improved quality of product. With shorter distances to milk house there is less likelihood of milker pouring milk into large containers in the stable. Less sediment in milk.

5. The disadvantages of the two-unit system are:

(a) Increased possibilities of transmitting disease through the herd by way of grain box where successive cows are fed in the milking barn.

(b) Poorer facilities for showing cows advantageously. Visitors interfere more with milking.

(c) Two to four days required to break cows to system.

(d) In general, a higher type of intelligence is required in the laborers for successful operation.

Agricultural Fuels and Lubricants[1]

FOR some time studies of fuels and lubricants for internal-combustion engines, and related problems of engine performance, have been under way by the Society of Automotive Engineers, American Society of Mechanical Engineers, American Petroleum Institute, and others. The purpose of the Committee on Fuels and Lubricants of the American Society of Agricultural Engineers, in its activities, is to conduct a similar study in connection with agricultural engines.

There does not seem to be the close contact between the tractor manufacturers and oil companies that has been developed between the automobile manufacturers and oil companies. This relationship should be cultivated as a guide to future policies. It was also brought out that considerable misinformation on fuels and oils has been distributed among farmers, and it was felt this should be counteracted. Two members of the Committee volunteered to write a farmers' bulletin on the subject, the rough draft of which has now been prepared.

At its first meeting in Detroit on April 1, 1931, the Committee visited the Ethyl Gasoline Corporation's research laboratory and the research laboratories of the General Motors Corporation. Besides viewing the interesting and informative work in progress, the committee discussed with the engineers of both companies many problems of mutual interest. (Preliminary to this first meeting the chairman and vice-chairman visited each of the other committee members in order to pave the way for its work. For the same reason some twenty tractor manufacturers were asked for information regarding their products. They responded practically one hundred per cent. Compression ratios were found to vary from 3.54 to 1 to 4.6 to 1, or one complete ratio. Practically all tractors were listed to burn gasoline, sixty per cent could burn kerosene, and a few could burn distillate. Only about 50 per cent recommended oil by S.A.E. viscosity number.)

During the period May 7 to 20 three members of the Committee visited some fifteen tractor and engine companies and discussed with them their ideas as to the future trend of tractor development. (The Nebraska tractor testing laboratory was also visited.) The use of gasoline was preferred by the majority of manufacturers consulted for obvious reasons, but many manufacturers had by force of circumstances equipped their tractors to burn kerosene. This naturally necessitated the use of lower compression which, together with necessary heating accessories, tends to cut down power and increase fuel consumption when burning gasoline. Gasoline is burned by 50 per cent of the farmers in a number of states because of the practically equal price of the two fuels, particularly where the tax is refunded on gasoline used for agricultural tractors, as is the case in 75 per cent of the states. It would seem, then, that kerosene should not be considered.

With distillate, however, another problem is presented. In certain areas, particularly the southeastern states, distillate is sold considerably cheaper than gasoline. This naturally appeals to the farmer. However, as the trend in oil refining is to increase the yield of gasoline per barrel of crude, distillate would become less abundant with a consequent rise in price. There is also a possibility of a tax being levied generally on distillate, as has been done already in one or two states. This same possibility would apply to oils used in Diesel engines.

In order to get some first-hand information of a preliminary nature on the committee assignment, a conventional 4-cylinder tractor engine was taken to the Ethyl Corporation laboratories in Detroit where such alterations were made as might increase the power. The compression pressure was raised from 78 pounds to 115 pounds per square inch, the manifold was altered to allow direct exit of the burned gases, and a specially designed carburetor was installed. Many tests with various combinations of the above alterations, and using kerosene, distillate, gasoline, and an anti-knock fuel, showed the power could be increased considerably and fuel consumption decreased.

After these tests the same engine, equipped for producing maximum power, was reinstalled in the tractor and draft tests made. Preliminary trials, when using an anti-knock fuel, showed a considerable increase in pull over what would be expected normally. Cost of fuel per unit of power was lower, although this result is in no way final. Further work of this nature is to be done.

Because of the vast importance of the subject of fuels and lubricants to the tractor manufacturer, oil refiner and farmer, it would seem desirable that further conferences within the Committee be held and all available sources drawn upon for information pertinent to the subject. Closer contact between the oil and tractor industries, as well as within the tractor industry itself, could be established and maintained with benefit to all concerned.

[1]1930-31 report of the Committee on Fuels and Lubricants of the American Society of Agricultural Engineers—R. B. Gray (chairman), C. G. Krieger, Jr. (vice-chairman), Wm. Harrigan, W. P. Davies, W. H. Worthington, L. Jacobi, O. B. Zimmerman, E. E. Brackett, J. B. Fisher, L. G. Heimpel.

The Relation of the Agricultural Engineer to the Farm Equipment Industry[1]

By L. J. Fletcher[2]

President, American Society of Agricultural Engineers

ON APRIL 18, 1894, the National Association of Farm Equipment Manufacturers was organized and held its first meeting in Chicago. Measured in terms of the age of agriculture, these 37 years are but a day. Measured in terms of the increase of productive efficiency of the including one of the greatest advancements the introduction of mechanical farm power, will undoubtedly be recorded in history as including one of the greatest advancements which the industry of agriculture has ever experienced.

L. J. Fletcher

It is the purpose of this paper to show the service rendered by engineering in this development, and to point out further services to be rendered by this profession, and particularly the agricultural engineering branch.

At one time, the machines available to the farmer were few, simple and more or less standard for all farms. In the seal of the U. S. Department of Agriculture, a walking plow represents our industry. That it is a left-hand plow indicates that the standards committee still has work to do.

At first there was but a gradual growth in the number and complication of the new farm machines. Then, with the advent of mechanical power, there quickly developed a great variety of machines, differing in type, size, method of accomplishment of work and application to local conditions.

All modern farm machines, before they are delivered to the user, must have first received the skillful attention of the designing engineer who decides on shape, size, materials, mechanical features and the like. The production engineer next works out the methods and decides the production tools to use, to most economically build the farm machine as designed.

A discussion of mass production generates a great variety of opinions, depending on the viewpoint of the speaker, or more often the object he wishes to gain. Regardless of opinions, however, it can correctly be said that one of the greatest accomplishments ever achieved by a race of people is the development of the ability by the American nation to produce, in quantity, goods of all sorts. This task has largely fallen upon men of engineering training. Engineering skill is not an inborn ability, but is acquired only after much hard work devoted to learning fundamentals of mathematics, mechanics and the like, and from the experience of application. Furthermore, the engineer never reaches the end of his learning period, but he must constantly study to successfully create the new, or learn of the work of his colleagues.

The modern American has become so accustomed to discoveries and new technical developments that he takes them almost for granted. Yet, across the ocean a nation in awakening saw the great service rendered through mass production, by the engineers of this country, and decided to make a similar development, in her land, the single goal of her national ambitions and effort. It looked easy — raw materials, transportation, production machinery, some fitting together, and then —the avalanche of finished goods. But that country is learning that only through years of intelligent building up of the vitally inter-related services of industries, public utilities and transportation, is smooth-running effective production made possible. So the great advancements made in the production of machinery by the American farm implement industry is largely a tribute to those men who make systematic use of organized facts concerning materials of construction and mechanisms; men who are today studying more than ever and looking only in one direction — ahead. They are seeking the engineer's goal of increased efficiency — more output from less input. They refuse to be misled into thinking that to produce an abundance of that which fills human needs and desires can be anything but an ultimate benefit to mankind.

While one part of our industry deals with production, the other deals with distribution. This is the field in which the agricultural engineer is finding the greatest opportunities for serving us. In fact, when comparing the two parts of our industry — production and distribution — may it not be said that greater progress has been made in solving the designing and manufacturing problems, than in solving the less tangible problems of distribution? Distribution deals with people. Unfortunately there is no "Brinnel test" for the customer, no templet or gage with its "go" and "no go" openings. The engineer desires to deal with facts, and he accepts opinions only in the absence of facts. Selling, on the other hand, seems to be largely an inborn and not an acquired accomplishment — an art, not a science. The salesman and engineer differ perhaps most widely in the degree to which they continue to study after they have launched themselves in their career. We have many "finished" salesmen.

Many sales managers stoutly defend the stand that the salesman should not be intimately acquainted with the mechanical design and construction of his machine, for this leads him to an intricate discussion of metals, mechanism, bearing sizes, steel analyses and the like, which is often of no value to the customer. We agree with these sales managers. However, we stoutly maintain that the salesman should know details of the technical utilization of the farm machines he is selling. These details have to do with adaptation of these machines to the correct performance of the jobs as they exist on the prospective user's farm. The salesman should be able to give a fairly accurate estimate of cost of operation and compare the probable saving derived from the use of the new machines over the present methods and equipment employed.

Since the correct utilization of a new farm machine demands an intimate knowledge of the soil, the contour and the cropping plan on any individual farm, it is somewhat natural for the salesman to rely largely upon the buyer to determine the advisability of a machine purchase. The relation, however, between the seller and buyer of farm equipment is rapidly changing, to that of a truly cooperative action in which the seller contributes his knowledge of the performance of his machinery and the buyer his knowledge of his local conditions and requirements. Cor-

[1]An address before the 38th annual convention of the National Association of Farm Equipment Manufacturers, at Chicago, October 1931.

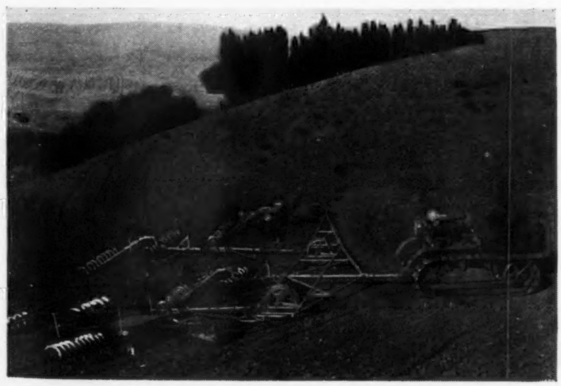
[2]Agricultural engineer (general supervisor of agricultural sales), Caterpillar Tractor Company. Mem. A.S.A.E.

rect selling must become the greatest service rendered by our industry.

What, therefore, is the relation of the agricultural engineer to the farm equipment industry? How can he help solve some of the problems now facing us? An agricultural engineer may be described briefly as a man who devotes his knowledge of engineering principles and application to solving the technical problems of agriculture. He must be acquainted with all the sources of information concerning the various fields of organized agricultural knowledge, and be able to translate the information gained from these fields into engineering terms and realities. He should be the connecting link between the great industry of agriculture and the profession of engineering.

Tremendous strides have been taken already in the engineering of the utilization of farm equipment. For example, establishing of standards of dimensions and operating characteristics, such as belt drives, power take-offs and drawbar heights, have been of great value to the user. There is, however, still opportunity along standardization lines. Accurate data and information on which to base farm equipment utilization is rapidly being secured, correlated and recorded by many agencies. In the experiment stations of the United States, in 1930, there were 130 research projects under way dealing with some phase of farm power and machinery. Among these projects were twelve dealing with tractors, seven with tillage machines, seven with draft of machinery, nineteen on harvesting or threshing machinery, twelve on the new subject of crop drying equipment, and nineteen on dairy machinery. Together with these projects were thirty-two dealing entirely with the utilization of electricity on the farm. These constitute about one-half of all the agricultural engineering projects. The remainder included studies of farm structures, soil erosion control, irrigation, drainage, sanitation, materials and land clearing. About $300,000.00 is annually expended on these agricultural engineering projects.

Our new Bureau of Agricultural Engineering in the U. S. Department of Agriculture, has established a most extensive program of investigation in farm power and machinery. Among the more important of these projects, many of which have been under way for several years, are the artificial drying of forage crops, direct harvesting and artificial drying of rice, machinery for controlling insect pests, corn and cotton production machinery, sugar cane harvesting machines, fertilizer distributing machines, machinery and methods for corn borer control, and cotton ginning investigation. In addition, it is planned to make a new extensive study of the utilization and cost of power and machinery in agriculture. Much has been accomplished in aiding the development of machinery for the growing and harvesting of sugar beets. In the words of a grower, they are putting a seat on the hoe. One of the major projects of the new bureau, which is being carried on in full cooperation with other bureaus of the Department of Agriculture, is that of soil erosion control.



Pulling five 10-foot double disks in the Palouse wheat country of Washington

Much of this work as well as the work of the state experiment stations has to do with the establishing of requirements for farm machine design. For example, in the study of fertilizer distributing machinery, much has been learned as to the method of application, which gives the safest and most efficient use of the fertilizer. In a recent report of this work, a member of the Bureau described a project in which a larger crop return was secured from the correct location as related to the plant, of 125 pounds of fertilizer per acre, than where 500 pounds had been broadcast.

Agriculture is a complex industry with variations of soil, topography, climatic conditions, crops produced, insect pest control and the individual desire and ability of the farmer. The fitting of the proper machine into every situation is becoming a very real task. In recent years, there has also been developed the tendency to fit the situation to the machine, for example, altering row spacings; and, through plant breeding, the characteristics of crops have been altered to allow more efficient use of machinery.

American farmers are on the threshold of another great advance in productive efficiency. Sizes of farms are changing so as to better utilize the present power operated machines, which have followed the development of the tractor. Modern machinery is not tending to eliminate the family-operated farm, but, on the other hand, is giving the farm family the opportunity to demonstrate its ability to meet changed conditions and continue as the best form of farm organization for economic production, as well as social welfare. In certain areas, however, family-operated farms have materially increased in size as new machines have made possible increases in the acreages which may be profitably handled by the family.

Therefore, the first of the two classes of service rendered by the agricultural engineer to the farm equipment industry is that of forming the bridge between the field of practical and scientific agriculture and our experimental or designing departments. This engineer should bring to this industry the real requirements which a new machine must meet. Alterations, costly both to the user and to the builder, will be greatly reduced by machines, which, when first produced, most nearly meet recommended and proven practice.

The originating of a new idea for agricultural mechanization may be the work of but one man. The embodiment of this idea in a new machine may be the work of but a few trained men, but the carrying of this idea, in the form of a new machine, into the vast agricultural areas of the country, and correctly applying it, is a great task involving thousands of men. Just as all of the men in the factory are not engineers, so all of the men in distribution need not be fully trained in the technical utilization of the machine they sell. However, it is in the field of improved utilization of modern farm equipment wherein lies the major service of the agricultural engineer.

Tremendous progress has already been made in this field, and it is from the results obtained that the desire arises for even a better service. The teaching and extension staffs of our great agricultural colleges have devoted much of their time and energy to the subject of more profitable use of farm equipment.

Tractor schools have been conducted by the hundreds, both under the direction of public institutions, as well as by manufacturers. But the development of the farm machine has been rapid, and, if anything, has tended to outrun the farmer's knowledge of most economic utilization. Quoting a prominent agricultural engineer in public service, he states: "I believe that, in the farm machinery field, we are approaching a new era which has developed out of the present necessity to produce quality crops at lower cost. It is pointed out by some that American agriculture is overmechanized. It is my belief that our agriculture is not overmechanized, but at present is too loosely mechanized from the standpoint of both technological and economic requirements."

Much good has resulted from the work of the joint Committee on Cooperative Relations formed by the National Association of Farm Equipment Manufacturers and the American Society of Agricultural Engineers. It is the duty of the N.A.F.E.M. representatives on this committee to keep closely in touch with the work of the agricultural colleges and the Bureau of Agricultural Engineering in the U.S.D.A. As a further evidence of our interest in improved utilization of our equipment, the various members of this association have loaned thousands of machines to the agricultural colleges for use in their instruction work and experimental projects.

As an indication of how the viewpoint is changing toward farm equipment, I wish to relate an incident which happened at a recent meeting of grain growers. An experienced and much respected director of a government experiment station was requested to describe how he would now go about establishing himself in the farm business. In brief, his reply was: "After deciding on the general locality in which I would farm and on my cropping plan, I would first buy a complete line of farming equipment so balanced in size that each of the various operations would be done properly and on time. The capacity of the equipment would depend on my available capital. Second, I would secure the use of the area of land for which my equipment was suited."

Thus the place of farm equipment has advanced from its early position of a few simple tools, based on the plow, through the period of displacement of hand labor in the planting and harvesting of crops, into the era of power farming with its increased variety of machine units, improvement of design, and vast possibilities. Now mechanical farm equipment may correctly be considered as the first essential for profitable agriculture. To the sound advancement of this latest development the agricultural engineer has contributed much.

Thus the agricultural engineer brings to the farm equipment industry assistance in two major fields — (1) in the design of new machines enabling them to more nearly fit the requirements encountered in the field, and (2) the better selection and utilization of the machine on the part of the farm operator.

RESULTS OF FARMING WITH MACHINERY

The present world business situation is prompting suggestions for a great variety of changes in the economic and social structure. Occasionally one hears that it might have been far better if no farm machines had been developed at all, thus providing, on the hand-operated farm, a continuous haven for anyone who may have become dissatisfied with other fields of occupation.

In 1820, eighty-seven per cent of the seven million people living in the United States devoted their time entirely to the production of crops and livestock products. They worked long and hard to feed and clothe themselves and produce a surplus sufficient to care for less than 1,000,000 people.

In 1925, less than 25 per cent of our 110,000,000 people were engaged in crop production. They worked shorter hours, expended much less physical energy in the accomplishing of their tasks, and yet produced enough to care for themselves and 82,000,000 of their fellow citizens, and, in addition, a liberal amount for export.

Perhaps one of the most striking comparisons ever arranged to show the contrast between the old and the new agriculture, was included in the pageant depicting the development of harvesting machinery at the time of the 25th annual meeting of the American Society of Agricultural Engineers at Ames, Iowa, last summer. A tractor and combine operated by two men proceeded steadily across a field of grain. These machines were followed by what first appeared to be an orderly mob. As the group came closer it was noticed that 12 men carried hand scythes with fingers attached for cradling. They were followed by 12 men whose duty it would have been to bind, by hand, the cradled grain. Following these were 48 men, each with a flail on his shoulder. It would have taken the combined labor of these 72 men, working hard through all the hours of daylight, to harvest and thresh as much grain as the two men with the tractor and combine.

The members of the farm equipment industry can well be proud of their part in relieving the human race of the extreme drudgery of hand production of crops. Through the releasing of millions from this laborious occupation, there has been made possible the building up of our great industries, transportation systems, educational institutions with their multitudes of students, the professions and our facilities and freedom for recreation; in fact, much that we think of as depicting our present civilization.

But as we listen to this soothing broadcast of our virtues, there breaks in the static of the "surplus" with all its evil satellites. Before we could reach out and collect with us our associates in the fertilizer industry, or gather in those responsible for the vast increase in the efficiency of the utilization of feed in the production of milk, beef, pork, eggs and poultry; or those responsible for the better control of plant diseases and insect pests, we were made almost the sole target of those who seemingly discovered that our virtue, i.e., increased efficiency in farm production, was all at once a great sin. Who asked for more efficiency (for the other fellow)? We had no right to save labor (that is, the other fellow's labor).

The progress of civilization is an odd phenomenon. Just as we have little control over the forces of wind, rain, freezing and earthquakes, which are constantly changing the contours of the earth, so in effect we have little control over the less tangible forces which are ever changing our economic and social composition. It is human, in looking upon the past, to remember only the beautiful and to forget the drudgery. As before stated, there are some who would like to make possible the placing on the land of the present unemployed. They draw beautiful pictures of the independence of this new farmer, producing all he needs to eat, assured of shelter, wood for fuel, from the everpresent woodlot, and during his odd moments producing clothes from fiber crops or skins of animals. Without commenting on the desirability of this mode of existence, it may correctly be said that, if every person in the United States should directly engage in agriculture, using the hand methods of the early farmers of this country, within a few years our population would either be forced to import foodstuffs, on loans advanced by other nations, or run the danger of undernourishment bordering on starvation. One of the principal reasons why, with hand methods, we would now have difficulty in producing ample foodstuffs, is that, since the early agriculture of this country, insect pests have entered the scene, adapted themselves to local conditions and may be kept under control only by the use of mechanical means of spraying, dusting or timely field operations. In addition, soils have been depleted so that fertilizers must be applied. Erosion has washed away much of our fertile top soil, and it is only with proper control and correct cropping methods that we will retain the soil that remains and build it up. We are now farming thousands of acres of marginal land, which could not produce crops at all under hand methods of operation. Historians have estimated that there were never more than 250,000 Indians living within the present boundaries of the United States, and at no time were all of these tribes free from starvation.

Any attempt, therefore, to force more people into an industry than is needed for economic production, will result in either a material decline in the standard of living of those people in the overcrowded industry, or a government-provided subsidy must come to their aid (and keep coming).

Whether we wish to or not, we cannot turn back. Next year will be 1932 — not 1832. The American farmer with his initiative, vision, and ability is going forward to far greater heights of production efficiency and living standards, to which progress the farm equipment industry will vitally contribute.

The Training of Research Workers[1]

By Dr. Andrew Boss[2]

IN ACCEPTING the subject assigned to me for discussion, I have made certain assumptions which I shall state so that we may approach the topic with a common understanding. I have assumed (1) that research work is recognized as a specific function in the advancement of science; (2) that it is advisable to develop in the research worker a knowledge of the methods and technic of science; (3) that this knowledge and technic can best be developed by the individual through a suitable course of education, training and experience. The discussion, therefore, will bear upon the nature and method of science as well as upon the specific training of research workers.

A dictionary definition of science is "Knowledge which has been systematized and formulated with reference to the discovery of general truths or the operation of general laws." The basis of science lies in the nature of the universe. The scientist attempts to learn about and understand nature by asking questions of her and systematically recording and interpreting her answers. Of science, the late Dr. E. W. Allen of the Office of Experiment Stations once said, "What we regard as science at any particular stage is of slow growth and represents many changes. It is never complete but is constantly being supplemented, corrected and revised. It is developed through the accumulation and study of records obtained by experimentation, observation, measurements, and from existing sources, and beyond this it grows and strengthens by discussion and criticism. Science, being man-made, is not absolute but relative; represents the highest degree of probability attainable at a given time; and is in constant state of change. It is an intellectual product, which takes form in the human mind, and consequently the quality of it bears a close relation to the development and equipment of the producing intellect. Its ground work is evidence, and its validity depends upon the quality of the evidence and the accuracy of its interpretation."

TECHNIC ESSENTIAL

Method, as applied to science, relates to the principles of securing accuracy. It is the art of making adequate, durable and trustworthy records. Errors must be avoided and opinions and personal bias must be eliminated. These are the most serious impediments to scientific advancement. Unbiased evidence is fundamental to sound conclusions. Let me quote again from Dr. Allen on the importance of valid evidence. He says, "The basis of evidence is facts, resting on precise observation and experiment, multiplied sufficiently to give validity. Facts differ widely in their importance. Even among well-established ones, some are pregnant while others are sterile; some have no reach; they teach us nothing beyond themselves, and the person who has derived them has not become more capable of foreseeing other new facts. On the other hand, there are facts of great yield; each of them marks a definite contribution or step in advance, and paves the way for further progress.

"The visualizing of the kind of facts needed to advance knowledge of a subject and the selection of those applicable is a part of the modern scientific method. It gives direction to the undertaking, in place of the unguided, fortuitous gathering in of whatever shows up. It implies going after the facts needed, rather than waiting for them to appear in the dragnet."

The objective in research is to discover new truths. Research implies the making of records and the determination of individual and collective facts, as a means of discovering a new natural law or a general principle or truth. It involves the element of inquiry and is productive only when directed systematically and in a productive effort. Research workers are therefore primarily fact gatherers and fact interpreters as related to what we are pleased to call the universe. Isolated facts have little value in changing the status of knowledge. As Agassiz has declared, "Facts are stupid things until they can be combined into truth," or, as Poincaire has contended, "Science is built up with facts, as a house is with stones, but a collection of facts is no more science than a heap of stones is a house." Out of research should grow new and real contributions to knowledge. There is a difference between a contribution to knowledge and an addition to the bulk of reading matter already accumulated. Quality rather than volume should be the criterion of values in research.

Research is objective. It should be narrowed down to definite purposes. The aim should be to disclose new contributions to be fitted into existing knowledge. These contributions fill in the gaps between the known and the unknown. A distinguishing feature of research ability is the skill and ingenuity expressed in discovering the facts, in assembling them, and in interpreting their influence on the problem studied. It has been said that research is an attitude of mind. If so, it must be an attitude of sound inquiry, of thoughtful consideration, and of concentration of mind upon the problem in hand. Its successful prosecution requires individual initiative, a quality which may be best trained and developed in an atmosphere of scientific inquiry.

EDUCATION FOR THE RESEARCH WORKER

With this understanding of the nature of science and the function and objective of research, we may now turn attention to the matter of education and training for research workers. The most desirable qualities in a research worker may be listed as (1) vision, (2) perception, (3) imagination, (4) sound judgment, (5) technical skill and (6) ambition. Can these qualities be developed by training? If so, how? It must be admitted at the start that there is a difference in material from which research workers must be selected. Not all will respond to the same type of training. And some will require more than others. No exact formula for training can be given that will meet all needs. Many will contend that ability for research is a quality born with the individual; that it can not be achieved by training; that genius has a major place in research. Since Edison has characterized genius as 90 per cent perspiration, this is probably true. Genius has also been defined as the capacity for taking infinite pains, and that surely is required of the research worker.

In my opinion, the most important quality of those listed is the first one, "vision." Without it, we are told in the Proverbs of Solomon, "the people perish." And certainly the worker without vision will soon perish in the field of scientific research. The ability to see the problem, or problems, in relation to other problems and in relation to the known laws of the universe; to foresee cause and effect; and to make the intangible tangible is of the first order in research. Vision leads naturally to the second quality, "perception," which may be characterized as the ability to see understandingly, to grasp mentally with precision and assurance. A lively "imagination" plays an important part in research. Imagination has been described as "that powerful faculty with which we conceive of relations which are beyond the reach of our perception through the senses, without which there is no progress in science." There are many gaps in knowledge between the concept and the conclusion which must be spanned by imagination until soundings can be taken. Imagination must be controlled by experiment, observations, and experi-

[1]Paper presented at the 25th annual meeting of the American Society of Agricultural Engineers, at Ames, Iowa, June 1931.

[2]Vice-director, Minnesota Agricultural Experiment Station.

ence, else it may lead to error. But, under control, it plays a large part in getting results. No doubt many people are born who possess one or more of these desirable qualities. Few, however, possess all three. And of those that do, few fall into the ranks of research workers. It becomes evident, therefore, that if the continuing demand for research is to be met, research workers must be supplied from the ranks of mankind, through institutions qualified to train them.

TRAINING

The matter of training research workers involves two well-defined phases: (1) Gaining a fund of knowledge about the nature of the universe and the natural laws governing it, and about the world as it is with what is known about it; and (2) technical training in the methods of research. The former can be done in the shortest time and probably in the most approved manner by a carefully chosen course of formal education. The earlier in life one can begin on such a course, the better, though there is little hope for the stimulation of an interest in the natural sciences in pre-college schooling.

It is granted that inspired teachers in the grade and grammar schools often stir the imagination and fire the ambition more than do those meeting the students in later college life. It is to the colleges and universities, however, that we must look for those phases of education that bring to the mind of the student a comprehension of the nature of the universe in all of its complexities and that eventually enables him to see it in its interrelated parts. To reach this objective, the college course should be broadly foundational, without too much specialization. It would be well perhaps to recognize the limitations of time and confine major attention to one of the commonly accepted subject matter fields, such as the engineering sciences, the biological sciences, the social sciences, or other general science fields. Any one of these is broad enough to fully tax the capacity for learning of most college students. The objective of the college course should be to learn, so far as possible, what is already known of the world and its environments, and to get acquainted with the literature about it and with the ones who made the literature. This latter matter is one that is too often overlooked, and as a consequence there is much reading without understanding. In addition to a sound knowledge of the natural sciences, one should have a working acquaintance with literature and the languages, with economic history, theory and geography, with mathematics, with geology and astronomy. These may not be used specifically as such in scientific research, but will give confidence of mind and intellect and serve as a useful background for deeper studies of a specific character. It is with regret that I note what seems to me to be a tendency toward earlier and still earlier specialization in our undergraduate college courses. Such specialization tends to narrow rather than broaden the vision and to limit the knowledge of essential existing relationships. It is this tendency which has led a prominent educator to classify a specialist as "one who knows more and more about less and less until he comes to know absolutely everything about nothing."

Broad training in the fundamental sciences and the humanities is a sufficiently ambitious program for the college student who expects to prepare for a life in scientific research. There may well be some slight specialization in the senior year, but the major specialization may be delayed without serious loss until advanced or graduate work can be undertaken. Perhaps I should explain that I can not conceive of one making much headway in research without at least the equivalent of the doctorate in systematic, intensive reading, study and discipline of mind in the chosen field of endeavor. While there may be individuals who are able to make real contributions to science without much preparation, they are found all too rarely to put reliance on them for solving the vast unknown problems of the present day. It is to the graduate schools of our best universities that we must look for the education of research workers of the future. In these are found the libraries and the literature that link the present with the past and point the way to the future. In these also are most likely to be found the men of science with vision and perception who can impart that vision and perception and stir the imagination of youth. And that, you are reminded, is a first step in preparation for a career in research.

It appears futile to attempt to separate the two phases, education and training, in outlining the sort of preparation that should be provided for entrance to research work. It is hard to conceive of one making much progress in acquiring training for a specific line of research without at the same time adding to one's fund of knowledge, or education. And yet there are required in most lines of research certain mental processes and manual skills that can be acquired only through persistent and thorough disciplinary measures; by rigid and repeated experiences in the involved procedure and the refinements of technic necessary in the routine observations, measurements, tests, and records of a complex problem. Research is considered by many as an individual matter, that involves originality, initiative, and imagination. I am of the opinion that the acquirement of these qualities can be greatly expedited by a season of experience under the guidance of productive investigators. It is not at all essential that all of this experience be gained in the specific line in which one is later to engage. The important thing is to gain the viewpoint, the inspiration of great scientists, and the knowledge of method that may later be useful in individual research. Often this experience can be gained while taking graduate work, in universities having strong research departments, or experiment stations. Such arrangements are highly desirable for the reason that the atmosphere of research there found creates a favorable environment for the development of the research spirit in the one taking the training. Contacts with eminent scientists, course work in the chosen line of specialization with instructors of strong mind and exacting requirements, and frequent ventures into written and oral discussion will help greatly in acquiring the ability to analyze, to deduce and to express ideas in approved form and style. One can hardly overemphasize the importance of a liberal, formal education in preparation for a life work in scientific research, and yet it is not more important than the experience and training to be gained as an apprentice at the side of an inspired and creative leader in a chosen field of research.

As I look about me in the field of agricultural research, in which I have had a somewhat extended experience, I am struck with the impression that most of the real progress in research has emanated from comparatively few centers and that a few men of unusual research ability are responsible for the rapid advancement of the sciences. Of this I am certain, some of these scientists have been much more productive than others in their written contributions and these appear also to have trained more students and young research workers. They appear to serve as magnets, drawing to themselves those who desire the experience of working under or along side of one who is eminent in his field that they themselves may become eminent. My advice, therefore, to the young men seeking preferment in the research field is to first gain a sound education in the fundamental sciences, and then to hunt out and attach themselves as firmly as possible to an outstanding leader in the chosen field and serve a productive apprenticeship. The student should gain as wide an acquaintance as possible with others in that field and remember that one will get no more out of research than one expends in concentrated, systematic personal effort. It is in these ways that he will gain the other qualities I have said are desirable in a research worker, namely, sound judgment and technical skill.

SUMMARY

The first duty of the trainer is to select carefully the trainee through close acquaintance with his scholastic record, his quality of intellect and his habits of industry and concentration. These qualities may be difficult to detect in the raw product, but they can be shown up under sys-

tematic test. When a worthy subject has been found, enlarge his vision and strengthen his qualities of perception by requirements in general and analytical reading. At the same time, stir his imagination and fire his ambition by setting up lively objectives and high ideals. Particularly should emphasis be placed upon quality of work. In these days of rapidly developing technique, scientific methods are becoming more and more exacting and difficult. Guidance in reading, of methods of work, and to some extent of his thinking is highly important to the beginner. And, finally, when the worker in hand has developed proficiency and shows ability and initiative, give him an opportunity to lead and let him have his head. Let him carry responsibility and learn to gain the cooperation of others. He likely will make mistakes; he may even fail in the research he undertakes, but I am talking about training for research workers and that is part of the process. It may be hard to bear, but it is a part of the making of a scientist.

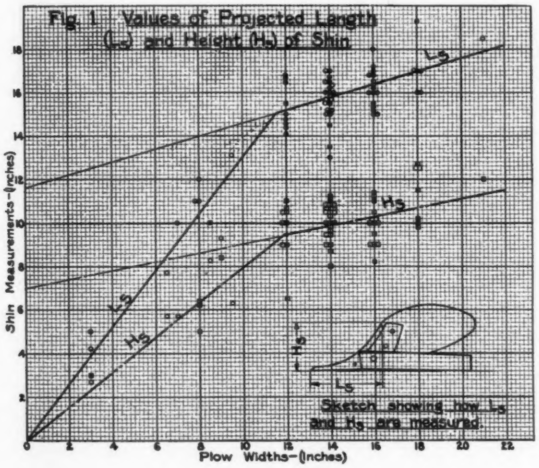
A Method of Comparing Plow Bottom Shapes

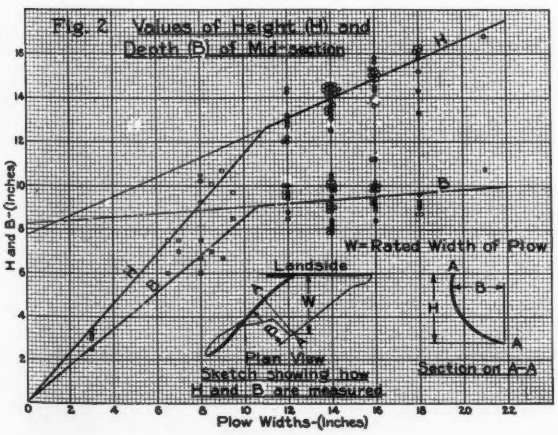
By Wallace Ashby[1]

SOME forty styles of plow bottoms were loaned to the Bureau of Agricultural Engineering, U. S. Department of Agriculture, by leading plow manufacturers for use in a study of plowing as a means of European corn borer control. They ranged in size from 12 to 18 inches, and almost all of them were classed by the makers as general-purpose bottoms. Nevertheless, when set side by side considerable differences in shape were apparent; as a matter of fact no two models were alike.

These plows were tested in cornstalk fields. Records were kept of their ability to cover stalks and of their power requirements. The results show clearly that shape of the plow bottom is a factor in both covering ability and draft.

[1]Senior agricultural engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Mem. A.S.A.E.





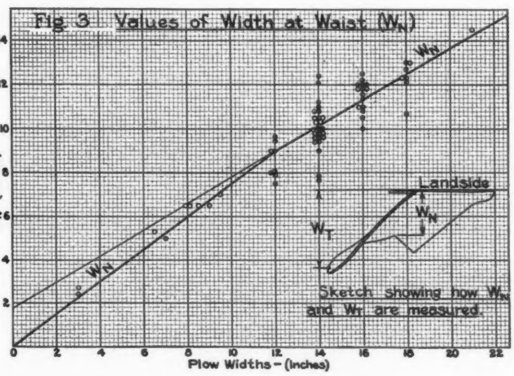
In order to study carefully the relationship between shape, covering ability, and draft, it was necessary to measure each factor and express it in numbers. Thus draft was expressed in pounds per square inch; covering ability — or rather failure to cover — in percentage of stalks left uncovered after plowing.

A review of the literature on plowing, supplemented by inquiries among several leading manufacturers, indicated that there was no accepted method of measuring plow bottom shape. Therefore, in order to complete the study, the following method was devised. It has been useful in studying the relationships outlined above, and is described here in the hope that it will also prove useful to other workers in the fields of plowing and soil dynamics, and that needed additions and corrections will be suggested.

On account of the warped, three-dimensional nature of the plow bottom and its lack of definite corners, measurements might be taken in almost any number of ways. Perhaps the scientific way would be to develop the equation and limits of the surface, but this is a complicated undertaking, and the fact is that practically all plow bottoms now in use were developed in the field by men who knew plows from the practical side and gave little thought to theoretical consideration. Therefore, from a practical standpoint it seemed necessary to find a simple and direct way of measuring some of the most important features. After a great deal of trial-and-error experimenting, the following tentative set of standard measurements or indices of plow bottom shape were adopted:

1. Projected length of shin (L_s, Fig. 1)
2. Height of shin (H_s, Fig. 1)
3. Height at "full-cut," or mid-section (H, Fig. 2)
4. Depth at "full-cut" section (B, Fig. 2)
5. Width at waist (W_N, Fig. 3)
6. Width at lower corner of wing of mold (W_T, Fig. 4)
7. Height at lower corner of wing of mold (H_T, Fig. 4)

Two other measurements will be described later.



Some 65 plow bottoms of different makes and shapes, and ranging in size from 3 inches to 21 inches were measured to find the values of the indices described above. The results are plotted and curves fitted in Figs. 1 to 6. Each curve is intended to express the typical values of one index through the entire size range. The curves show very clearly that a series of plows of one make and intended for the same soil conditions are not duplicates of each other on different scales.

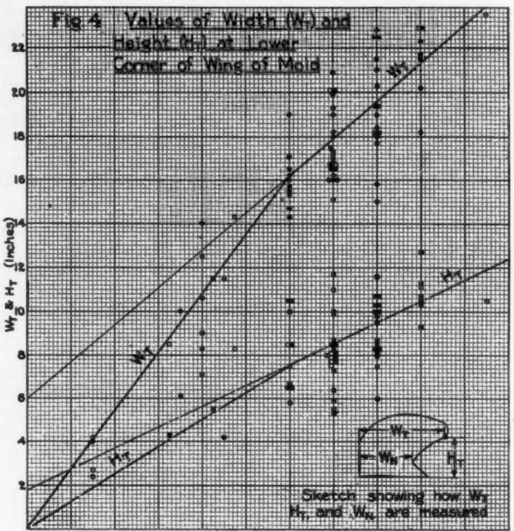
Curves in Figs. 1, 2, 4, and 6 are particularly interesting because of the sharp break near the 12-inch size. It appears at first glance that large and small plows follow different laws of relationship between the values of these indices and the width of cut, but since this does not seem logical the following explanation is offered.

Length and height of shin, height and depth of full-cut section and width and height at wing depend on both width and depth of furrow. With the small sizes the depth of furrow is limited by its width (It is commonly accepted as one-half the width), but in the case of the large plows the maximum depth of furrow is limited by the depth of the top soil. Usually on account of soil conditions it is desirable to plow little if any deeper than is possible with a 12-inch plow, and the larger bottoms are designed accordingly. In other words, the breaks in the curves indicate that the depth factor increases as the width of cut increases from 0 to 12 inches, but remains practically constant through the size range beyond 12 inches.

The relationship between field performance and the shape characteristics listed above was studied by correlation methods. Since the results showed the need for additional information regarding shape, two special indices were devised, as follows:

8. A contour (called "upper standard contour") was drawn on the moldboard at approximately 0.85 of the normal height at full-cut section above the base plane, and a tangent was drawn to the contour at a distance from the vertical plane of the landside equal to the rated width of cut of the plow. The angle between the tangent and the plane was called the upper standard angle (S, Fig. 5). This is the first special index.
9. A contour (called "lower standard contour") was drawn on the moldboard at a height corresponding to the ground surface when plowing at the ordinary depth, i.e., one-half the rated width above the base plane for plows of less than 12-inch cut; 6 inches above the base plane for plows rated at 12 inches or more width of cut. The point where this contour (projected if necessary) crosses vertically beneath the upper standard contour was marked and its distance to the vertical plane of the landside measured. This distance was called the width at crossing of the standard contours (W_x, Fig. 6) and is the second of the special indices.

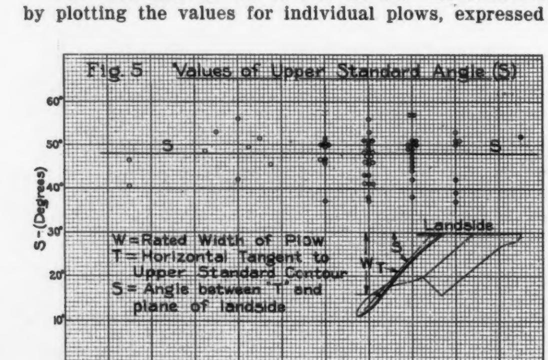
The usefulness of the various indices has been tested by plotting the values for individual plows, expressed as percentages of the normal values, against the results obtained with the plows in the field. Those that seem most important are: Width at waist, W_n; width at crossing of standard contours, W_x; the combination, width minus height at lower corner of wing of mold ($W_t - H_T$); the ratio, height over depth at full cut section (H/B); and the upper standard angle (S). The other shape indices were included since they are needed to complete the design of a bottom, and may be valuable in connection with some other branch of the work.

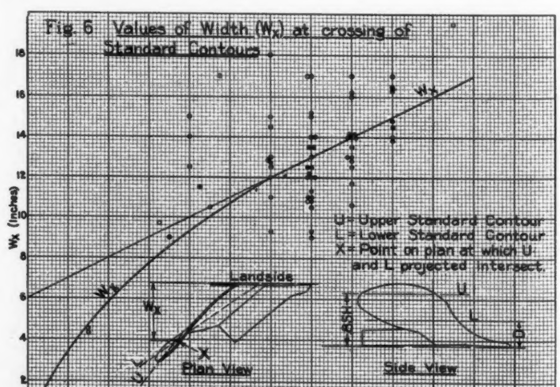


The graphs may be used as gages for comparing the shapes of bottoms of any width up to 21 inches. This is easily done by expressing the measured values for each individual plow in percentages of the typical measurements for a plow of similar size.

In comparing field performance with shape characteristics the field data are plotted against the shape ratios, or the two sets of data may be used in graphical or arithmetical correlation. In comparing shape characteristics of plows of different sizes, the ratios of measured to typical shape for each size of plow may be compared directly. It is hoped that this method may be useful to manufacturers in checking the shapes of bottoms of the same classification but of different sizes.

(AUTHOR'S NOTE: V. D. Young, assistant agricultural engineer, and A. L. Sharp, junior agricultural engineer, U.S.D.A. Bureau of Agricultural Engineering, assisted in preparing the data presented in this article.)





Characteristics of Rural Electric Lines[1]

By C. P. Wagner[2]

THE characteristics of rural lines result in numerous new problems for the distribution engineer. The discussion in this paper must consider those characteristics peculiar to purely farm lines constructed in the midwest agricultural districts, and not to the common distribution problem involved in rural service to the more densely settled areas encountered in some eastern sections where the number of rural customers may run from 8 to 20 per mile.

The territory with which we have the greatest familiarity has a statistical development something on the following order:

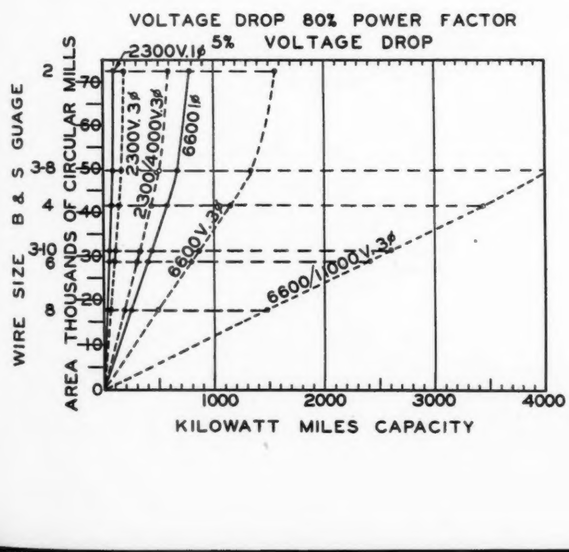
Average size farm	158 acres
Number of farms per square mile	3.28
Tenancy other than family tenants	30 per cent
Distance between towns of 100 or more population along railroads	8 miles
Distance between towns of 100 or more at right angles to railroads	18 miles

Essentially, such a territory is farm. In fact, in one area of 4500 square miles, which is equivalent to the area of Connecticut, we have an available 15,000 farms. Our company now serves 664 of these farms but reaches only 70 non-farm customers. Other companies serve about 700 farms in this area.

Obviously, a rural line system to reach such territories cannot take advantage of the various artifices for equal distribution of voltage as would be the case in a more thickly settled region. A line to serve such areas must ultimately reach approximately 20 miles from the service supply, the distance being that of the main line to the most remote point, but not including miscellaneous branches. At heavy loads, the customers near the service supply will not be seriously affected by line regulation. The customers more remote must be protected and probably the greatest difficulty lies in the high voltage, due to charging current when the line is lightly loaded. Thus, the service of such customers will have imposed upon it both the highest and the lowest voltage, or the maximum in variation from a standard. It therefore becomes a considerable problem to maintain regulation in regard to pressure on the line and keep within allowable limits for the maintenance of a satisfactory and quality service.

[1]Paper presented at the Rural Electric Division session of the 25th annual meeting of the American Society of Agricultural Engineers, at Ames, Iowa, June 1931.

[2]Manager, rural service engineer, Northern States Power Co. Mem. A.S.A.E.



The farms in our territory have widely scattered buildings, necessitating a rather intensively developed distribution system around the farmstead itself. This system costs considerable money and it is extremely difficult to obtain adequate expenditures on the part of the farmer to provide for voltage regulation within the system owned at the farm. In the city, the householder, apartment owner or skyscraper management usually provides an electric wiring system which will maintain a voltage regulation of 2 per cent from the entrance switch to the socket. To impose such requirements on the farm for the ideal load expected from the farmer, would cause both the agricultural engineer and the distribution engineer to be considered extremely exorbitant in their demands. At the present time, it seems to us that almost the best we can expect within the farmer's premises is a voltage regulation of 10 per cent. This includes the transformer drop at maximum load imposed on the individual system. For this reason, it becomes extremely essential that we maintain a low percentage voltage regulation on the main line itself. Perhaps this regulation is less expensive on the main line rather than within the farmer's premises.

Voltage regulation is affected by the conductor size, the conductor characteristics, spacing between conductors on the cross-arm, the maximum load on farms more remote from the station and the average load of the group of farms enroute. Many of these factors are highly varying in character. For instance, we will find that in a group of farmers the individual maximum demand of each farm may be something on the order of 7 kilowatts, while the peak demand of the line will react to an effect of 1 to 1½ kilowatts per farm. On lines of this type, it is essential that we state the line drop in percentage and the kilowatt-miles load, as they have a definite relation. It can be seen, therefore, that two farms on the end of a 10 or 15-mile line may react and affect regulation to the same extent that ten farms might affect the regulation of a 1-mile line. The reason for this is that the two farms may have coincident demands of 12 to 14 kilowatts, while it is almost impossible to obtain a coincident demand on 10 farms of more than about 1½ kilowatts per farm. Thus, on a 10-mile line, two farms may require a capacity for 120 kilowatt-miles, while 10 farms on one mile could scarcely require 15 kilowatt-miles. In view of these factors, it is essential that we set up a standard of a very low per cent voltage drop on the primary of a rural line.

If we find it necessary to establish 6600-volt lines as a standard, it would appear that a low regulation would not increase the cost over a period of years. It seems, then, that we save money for the farmer by setting a standard of low regulation, allowing him to maintain a slightly lower cost distribution system on his farm or giving him better service for the same cost. In many cases it will be very difficult to obtain standards of regulation on the farmer's premises comparable with those expected within the city.

It can be seen from this discussion that numerous conditions must be taken into the design plan. We would outline them in the following order:

1. The effect of line voltage
2. The effect of conductor size and its conductivity
3. The effect of varying allowable line drop in terms of per cent of line voltage
4. The effect of three-phasing, three-wire or three-phasing, four-wire, or construction of what is known as the "delta" or "star" three-phase line.

For the purpose of showing these various relations, we have constructed a kilowatt-miles capacity chart. It is necessary that we construct such a chart on a definite per-

centage voltage drop. Then, for any other voltage drop, our carrying capacity is in almost direct proportion. The chart which we use is based on 5 per cent, a point below which we scarcely dare go if we are to assume a coincident demand per farm of between 1 and 1½ kilowatts. The conductors shown on this chart are copper No. 8, No. 6, three stranded No. 10, No. 4, three stranded No. 8 and No. 2.

The area in thousands of circular mils is approximated. Various voltages are given, starting with our lowest acceptable voltage, 2300 volts single-phase; thence to 2300 volts three-phase, or three-conductor delta-connected service; 2300 to 4000-volt three-phase and four-conductor star connected system, which results in 4000 volts between line conductors but 2300 volts to each conductor to a floating or grounded neutral; 6600-volt single-phase, 6600-volt three-phase, three-wire delta-connected system; 6600 to 11,000-volt, three-phase, four-wire, 11,000 volts between conductors and 6600 volts to the floating or grounded neutral.

One particular fact must be noted, that on the first three lines the 2300-volt standard distribution transformers are used throughout the system, and on the second voltage, the standard 6600-volt transformers are used on the three circuits. It will be noted that, when the single-phase line is changed to three-phase, the capacity of the line is approximately doubled, inasmuch as capacity varies in proportion to the square of the voltage; the star-connected line with four conductors has about six times the carrying capacity as would the single-phase two-wire line, provided that the loads are balanced with varying intermediate effect on unbalanced loads.

On a 6600-volt line, again the capacity for single-phase is approximately nine times that of the 2300-volt, with similar relations for the 6600-volt three-phase and the 6600-volt four-wire three-phase. In regard to conductor size, the capacity of the conductor varies roughly with the proportionate area in circular mils.

All of these variable factors and their effects are shown relatively in the kilowatt-miles capacity chart.

In the earliest stages of farm electrification, great stress was put on extreme economy in the construction of lines. Little thought was given to the conductor material, other than its possible economy. In the secondary stage of the development of rural lines, a stage which occurred about 1924, particular attention was given to the types of conductor available and their characteristics. Many engineers in the interest of supposed economy, tried to obtain the manufacturer's consent to the development of special alloys of the peculiar characteristics necessary to withstand the weather, span length, stress and strain, without costing as much as copper. No thought was given to the fact that ultimately the loads would reach a point demanding a very low regulation factor or a relatively high carrying capacity.

TYPES OF CONDUCTORS

The conductors which have become available are (1) iron, (2) steel, (3) aluminum, (4) aluminum (steel core), (5) bronze alloys, (6) copper clad, (7) cable copper (copper clad, steel reinforced) and (8) copper. Plain iron or steel wire was thrown out almost immediately by the engineers, and the manufacturers of aluminum had long since ceased recommending it, excepting with the steel core reinforcing. Bronze alloys were scarcely accepted. Copper clad was offered in especially small sizes and might have become attractive had not the experimental projects suddenly determined that unheard of loads might exist on the farm. A copper-stranded conductor with the copper clad reinforcing has recently been offered. Its carrying capacities are given in terms of copper equivalent and its mechanical strength is very high, permitting its use for extremely long spans in areas of light ice or sleet and low windage resultants. The cost of this conductor may cause it to be prohibitive, excepting in fairly rough countries where it can be used to jump from hill to hill or mound to mound with spans of 400 feet or more; or in extremely level countries where it is possible to construct long spans and take advantage of the low sag required because of conductor strength. It might have its disadvantages in a heavy sleet area because of its size and the weight of the sleet which might be collected, together with the loading on poles which would result from such conditions.

Electricity must go to the farmer, not as a luxury, not because he demands it, nor because of political exigency, but because it is a needed service

The copper conductor has always been the standby of the distribution engineer, and he prefers to use it whenever possible. His construction crews are trained in its handling. He does not have to offer special engineering service. Therefore, copper is still the prime conductor for all types of electric lines.

The second conductor accepted in the construction of rural lines is the aluminum steel core. This is lighter than copper and the steel core gives great strength, permitting relatively long spans. It does, however, require a considerable sag, necessitating high poles. Perhaps the most objectionable thing about aluminum is that its lightness permits considerable vibration in the wind, necessitating great conductor separation in order to prevent short circuits. The use of this material then becomes much more involved if we are to have long spans and three-phase, three or four-wire lines.

The construction crews, not familiar with the use of aluminum and the special tools required, often add considerable expense to the line construction. More frequently they unknowingly abuse the conductor which causes ultimate release of the tension of the individual strands and a weakening of the line as a whole.

Originally steel core aluminum was fastened to the insulators with a nominally soft wire but it was found that the rapid movement of the conductor caused piling up at the insulator of a mechanical vibration. This resulted in the forming of aluminum crystals and ultimately caused snapping of the strands. For several years, the manufacturers have provided a long tie of special material extending some 1½ to 3 feet from the insulator. This stops the mechanical vibration before it reaches a critical position next to the insulator. In other words, the vibrating period is changed between the point at the end of the tie and the point at the insulator. This tie results in a satisfactory service.

Many engineers who consider themselves located in a heavy ice-loading district where heavy winds may prevail are prejudiced against the use of aluminum conductors.

The factors which control selection of the pole spans are

1. The strength of the poles
2. Strength of the conductors
3. Economic conductor sags
4. Conductor loading by sleet and wind
5. Clearances demanded by type of territory, by law or by conflict with other utilities.

We know of one case where the selection of the pole height and the particular conductor was a result of a study of agricultural economics, the effect of the rural rate on acceptance of the service by the farmer and the relative size of crew needed for placing poles of different heights. The engineer in question selected a 30-foot, 6-inch top pole, three-strand No. 10 copper, a 200-foot span and a standard four-pin cross-arm, on the basis that future extensions to the individual farmer enroute could be made with a minimum-size crew. Another line could have been constructed for approximately the same amount of money for first cost, but would have added considerably to the cost of individual connections at a later date.

The company executives decided that they could afford to take on the farmer who was properly established, able to advance the use of electricity and let the other farmers wait for the future for service. Some 30 per cent of the farms in the area were tenant operated by other than family tenants. It was expected that these farms would come on individually from time to time.

It may seem peculiar to argue that it is more economical to take on two-thirds of the existing farms than it would be if we were to take on all farms enroute. However, the cost of installing a transformer and lateral for an individual farm may be roughly about one-third of the total cost of the line per farm, and when we balance a very small use of service against this investment, we may find it much to the advantage of the power company to allow these farms to await connection until they have adjusted their financial condition to develop a better use of the service.

The U. S. Weather Bureau has plotted a rather reliable chart of the areas where each class of sleet and wind may be expected, which has been adopted as official by the Bureau of Standards in their publication "Standards of Safety for Electric Lines." It is estimated that the maximum condition in each territory will occur not more than once in each fifteen years. Therefore, if we design our rural line for a twenty-year life, it is reasonable to expect that the conductors will have imposed upon them the maximum weather strain twice during the life of the line, the first time in the early stage at which period some weakening will result but still leave a fair factor of safety for the second strain which might be imposed.

Modern pole availability permits us to draw on the pole life expectant up to about thirty-five years. Most engineers fear that pole hardware and conductors will not stand up for such a length of time. Therefore, there is a tendency to develop rural lines for a twenty-five-year life. Modern galvanizing makes available hardware which will stand up for this period of time. The type of conductors which we are using will in most cases just about have served their useful life during this period. Pole treatment for these lines is therefore purchased on the 25-year base, rather than the more expensive treatment for a longer expectant life. It appears that the most economical method of maintenance is a complete replacement of all materials at the end of a predetermined period.

Distribution systems in the past have had abnormal depreciation due to rapidly growing loads not foreseen when they were designed. Sometimes this type of depreciation is known as obsolescence depreciation. Therefore, when distribution engineers approached the problem of rural line construction, they felt that, if they selected a proper and adequate voltage and then constructed their lines to take advantage of the possibility of added conductors, changing of phases, etc., they would have a convertible development which could grow in multiple units and not require heavy obsolescence depreciation. It naturally follows that the annual fixed charges against one rural line may be less over a given period of time than those against another, even though the first cost was somewhat greater. This gives us a delicately balanced problem in distribution economics and the final decision might rest on whether or not the power company paid an earnings tax or a property tax.

Rural line characteristics, loads and obsolescence due to rapid growth of loads have made it difficult to maintain satisfactory voltage regulation and at the same time hold down the cost. If distribution engineers are to design economical and satisfactory lines, agricultural engineers must anticipate and advise them of future developments in farm loads

The Northern States Power Company and the Rome Wire Company cooperated in the development of a 6900-volt single-phase underground rural line, 3.4 miles long and serving eleven customers. Under good conditions this line could probably be built for about 25 per cent more than an overhead line of the same characteristics. However, the line is not convertible and while there might be low annual depreciation, again the question of property tax must be considered, as well as the problem of obsolescence depreciation which might be encountered in a poorly engineered area. Loads might be encountered which would overtax the cable and therefore cause great difficulty.

It is expected that the great value of these cables will result from using them at points between overhead lines where obstructions would require extremely expensive overhead construction. To test this practice we now have this cable connected from line to neutral over a 30-mile, 11,000-volt system. Further, we propose to extend some six miles of line from the other end of this cable, thus imposing upon it the maximum stress as concerns storm-generated phenomena.

The electrical engineer of the distribution department of a power company can design an economical line of the exact operating characteristics desired, provided we agricultural engineers supply him with adequate information. It is scarcely to be wondered at that he looks on us with askance when we confess in our assembled conferences that we know little of the possibilities of farm electrification. Naturally, if we, in our lack of knowledge of the subject, are unable to set before him a problem with our end of the solution fully determined, then he fears the results.

We have already made a number of changes in general distribution practices. The modern temperature corrected meter permits the connection of single-phase motors up to 10 horsepower on the same meter with small lighting loads, an impossible feat five years ago, if we expected to register our energy correctly. Many of us have, therefore, stepped our idea of the farm motor maximum size from 5 to 7½ or 10 horsepower. On one farm in Minnesota, we have five residences, a barn for 175 cows, a beef feeding shed for 200 head, a heating load of three electric ranges, one 10-horsepower motor, several 2 or 3-horsepower motors, numerous fractional-horsepower motors and lighting. We find that this load is handled nicely by one meter and that a 100-watt lamp starts the meter with a fairly accurate registration.

Future innovations in the art of rendering electric service to the customer, future demands of the farmer and future loads available on the farm may make available especially low rates and encourage especially high use of the service to a degree surpassing our present visualization of possibilities. What then can we expect when we as engineers of one profession approach the distribution engineer, one of another profession, and ask of him that he plan long-term investments on the basis of our present meager experience and ideals in regard to service to be rendered?

It is not the problem of this Society to design rural electric lines. It should, rather, see that its engineers go deeply into the future, not two, three or five years, but ten or fifteen years hence and determine what the farmer is going to do with electricity on the farm, what we are offering to reduce the farmer's financial burden, to reduce his physical labor and to permit him to increase his production at a lower cost per unit. Electricity must go to the farmer, not as a luxury, not because he demands it, nor because of political exigency, but because of the fact that it is a needed service. Furthermore, it must go to the farmer as a gift of engineering from the electrical and agricultural engineer.

General-Purpose Farm Equipment in Iowa[1]

By Arthur A. Collins[2]

A DISCUSSION of the best size of tractor for use in the corn belt naturally involves the subjects of crops, rotations and their associated tools and implements. I shall attempt to set out the experience of the Collins Farms Company, in so far as it relates to the question of economical mechanization of corn belt farming, and I will present my material from the viewpoint of a cost accountant and practical user of farm machinery.

For the benefit of those who are not familiar with the details, I will explain briefly the general method of operation of the Collins Farms Company. This company is operating approximately 30,000 acres of Iowa land, but in many ways its work is very similar to that of individual operators who have adopted machine methods. Our properties are rather widely distributed throughout the east-central and northern sections of the state, and, therefore, are not operated as a single body. We have grouped neighboring farms into units of from 500 to 1,500 acres under the supervision of salaried foremen who are retained from year to year. The foremen on the smaller units, although acting in a supervisory capacity, actually operate tractors themselves during the greater part of the season. All labor is performed by salaried or day-wage men. None of the land is being rented.

Our operations are confined entirely to grain production, no livestock being raised. Our rotations are as follows: First, a five-year rotation employing oats, wheat, biennial sweet clover and two years of corn; and, second, a three-year rotation employing oats, wheat and soybeans, with annual sweet clover sown in the wheat. Flax and barley are in some instances substituted for oats in these rotations. Commercial fertilizers are used very extensively applied with the wheat and corn. By the use of phosphate and legumes, we have succeeded in increasing our yields on our improved farms 50 to 75 per cent above the average in this state.

The company's operations are completely mechanized, no horses or other draft animals being employed. Our machine equipment for these rotations has been quite definitely standardized. It includes a general-purpose tractor, wheatland disk plow, heavy field cultivator, 16-7 double-disk grain drills, three section rotary hoe, twelve-foot windrower, ten-foot combine with pick-up attachment, and a two-row, tractor-mounted corn picker.

Our operating units are of a size that is to some extent comparable to the individually owned, mechanized farm and our rotation is typical of the best diversified farming of this section, so that the results of our experience can be considered as applicable to the problems of progressive individual operators. As a matter of fact, many of our methods are being adopted by neighboring farmers.

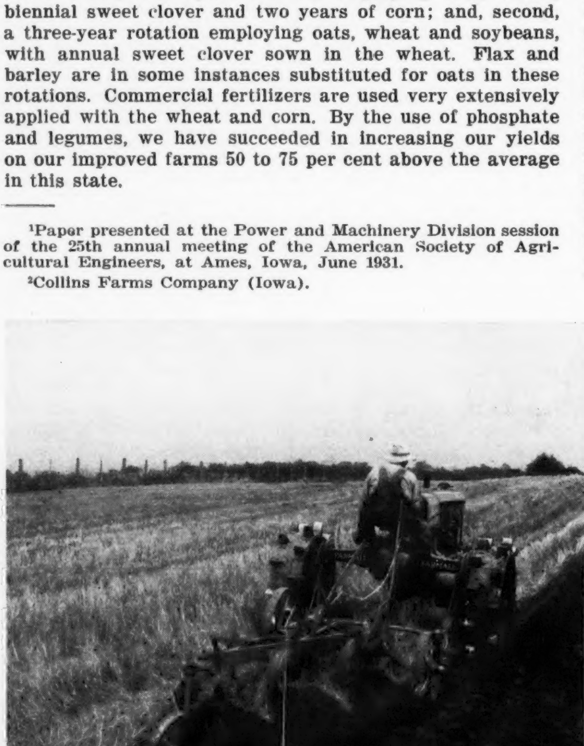
The theoretical factors influencing the most economical size of tractor can be tabulated as follows:

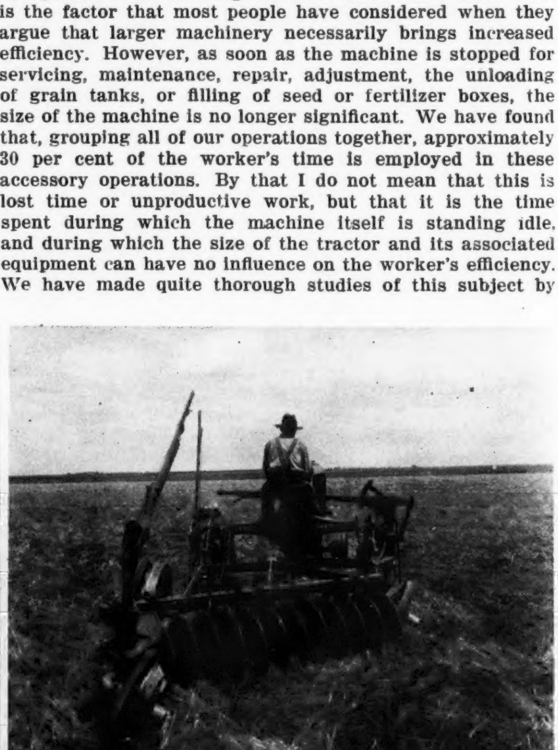
1. Productive capacity as measured by drawbar horsepower or otherwise
2. Total investment for machinery required for operating certain acreage
3. Cost of maintenance.

For most farm operations, the worker's productive efficiency will be directly proportionate to the power or size of the machine he is controlling, as long as it is actually in operation and moving forward across the field. This is the factor that most people have considered when they argue that larger machinery necessarily brings increased efficiency. However, as soon as the machine is stopped for servicing, maintenance, repair, adjustment, the unloading of grain tanks, or filling of seed or fertilizer boxes, the size of the machine is no longer significant. We have found that, grouping all of our operations together, approximately 30 per cent of the worker's time is employed in these accessory operations. By that I do not mean that this is lost time or unproductive work, but that it is the time spent during which the machine itself is standing idle, and during which the size of the tractor and its associated equipment can have no influence on the worker's efficiency. We have made quite thorough studies of this subject by

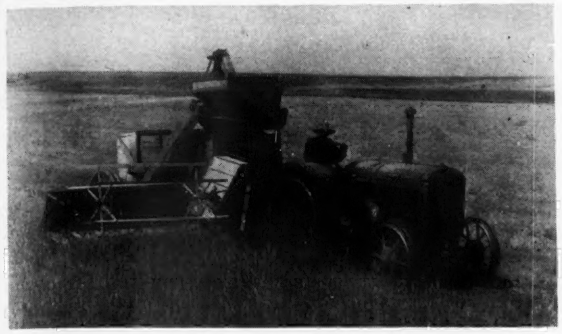
[1]Paper presented at the Power and Machinery Division session of the 25th annual meeting of the American Society of Agricultural Engineers, at Ames, Iowa, June 1931.

[2]Collins Farms Company (Iowa).





(Left) A large general-purpose tractor, the possibilities of which are discussed by Mr. Collins. (Right) The disk plow of the prairie wheat sections of the Southwest is also used effectively on the Collins Farms in Iowa



An eight-foot, one-man combine outfit, such as used on the Collins Farms. Mr. Collins hopes to adapt his ten-foot combines to the one-man principle of operation

means of automatic recorders placed on our tractors which show the periods during which the tractor is actually moving forward across the field, and by means of stop watch and motion picture observations on the various operations performed while the tractor is not in motion.

In regard to the second consideration, that of capital invested in tractor equipment, price lists of farm tractors indicate that the larger size tractors can be purchased at lower cost per drawbar horsepower than the smaller ones. The 10-20 general-purpose tractor is listed at approximately \$800.00, whereas the 15-30 tractor which actually delivers nearly twice the drawbar horsepower, is listed at about \$1,000. There is, therefore, considerable less investment for motive power if purchased in the larger units. The 15-30 tractors which are now available are all of the conventional four-wheel type which is not adaptable to corn belt operations but can be used for tillage and harvesting only. The three-wheel general-purpose tractor has shown itself so superior for corn belt work that it can be definitely said that, if a larger tractor were to be extensively used in this section, it should be of a general-purpose type. It can be assumed, I suppose, that a general-purpose 15-30 tractor could be manufactured and sold as cheaply as the standard 15-30. This company employs a few 15-30 tractors of conventional design. They are used during the peak loads which occur during spring and fall seedbed preparations and during harvest. About 80 per cent of our tractors are of the 10-20 general-purpose type. Our total investment in new machinery is \$6.71 per acre. The total charge for depreciation of machinery, a reserve for the purpose being set up at 10 per cent annually, is only between 8 and 9 per cent of our total production cost, so that a further reduction in investment for machine equipment would effect only a nominal economy.

In regard to maintenance, our service records show that the annual repair bill for a general-purpose type tractor which has been in operation approximately 2,000 hours is between \$125.00 to \$140.00. The repair cost for 15-30 tractors is from \$136.00 to \$180.00 annually. Therefore, it can be expected that there will be some additional gain in maintenance economy as the size of the power unit is increased, but this factor is also of a nominal importance.

Our opinions on the course of development in farm equipment as related to our particular needs are based on a very careful system of cost accounting, and a large number of field measurements. Although we feel that a great deal could be accomplished toward greater operating economies by employing a general-purpose tractor of considerably greater power than we are now using, the important savings which can be most readily achieved and should be the first to be given attention are those that can be obtained through simplifications of equipment. I have already listed the machines which we employ and have shown that we have reduced our investment in machinery to below \$7.00 per acre. The greatest demands for power are made during the preparation of the seedbed and during harvest, and it is in these two classes of operations that we have already accomplished rather remarkable economy.

First, in fall wheat seedbed preparation we have introduced the wheatland disk plow and we get the same economy in Iowa as is obtained in Kansas and the Southwest. We find that it is very necessary to obtain a firm seedbed for wheat, free from air pockets. The work done by the wheatland plow is much superior in this respect to that obtained in the moldboard plow because there are no air pockets, because the straw is mixed throughout the soil so that it will not destroy capillarity, and enough straw and trash is left on the surface to prevent blowing and drifting of the soil.

In the preparation of the ground for corn, we are making increased use of the field cultivators to replace plowing, especially for spring preparation. We use this tool to penetrate to a depth from eight to nine inches and go over the field three or four times, each time crossing the previous cultivation. After this is done, we have a finely pulverized seedbed, thoroughly stirred to a depth of from seven to eight inches and with the trash more or less carried to the surface. We have obtained increased yields of corn by using this method of preparation instead of plowing, especially in dry years, because of the better capillarity obtained. The general-purpose tractor will pull a heavy field cultivator nine feet in width. In this way the cost, both in labor and gasoline, of preparing seedbeds is reduced to 50 per cent of the cost by the usual method which involves plowing, disking, rolling and harrowing.

In addition to introducing the field cultivator and the wide disk plow as tillage tools, we have also reduced the number of plowings necessary to three plowings in a five-year rotation or two plowings in a four-year rotation.

We employ combines exclusively for harvesting small grain and soybeans. It is our practice to straight combine all our wheat acreage and to windrow all our oats, flax and barley. Following this plan our crops are harvested with the combine in the following order: Wheat, July 15 to 25; oats, July 25 to August 15; flax and barley, August 15 to 25; sweet clover seed, August 25 to September 5, and soybeans starting after the first frost, which usually means September 25 to October 10. Thus with our rotation the combine is employed over an unusually long period during the year, and there is much less peak loading of harvest equipment than there is in the one-crop wheat areas. Last season we employed several 8-foot, one-man, power take-off combines so successfully that this year we are equipping some of our standard 10-foot combines with one-man controls so a single operator will both guide the tractor and control the combine. He is to be assisted in servicing the combine by the truck driver who is hauling away the grain. In this way we hope to cut the labor for combining nearly in two. If this is successful, there will be little to be gained in increasing the size of the tractor so far as the operation of combines is concerned, since the medium-size general-purpose tractor is adequately large to power a ten-foot combine. It does not seem likely that a larger combine could be successfully adapted to one-man operation.

Experience over a period of four years has definitely demonstrated that the present general-purpose tractor is adequately large to handle the 10-foot combine and the tractor-mounted corn picker on all farms except the extremely hilly ones. At first there was some question in our minds on this point, but we now operate this equipment drawn by the general-purpose tractor on several rolling farms as a matter of routine.

I have already expressed the opinion that the greatest economies which can be brought about in the immediate future can be obtained by giving more attention to the tools and equipment which are associated with the general-purpose tractor and by more specifically adapting them to corn belt conditions. I believe it is quite possible to successfully apply the "general-purpose" idea to other implements as successfully as it has been to the tractor. As a

matter of fact, we have accomplished quite a bit along this line ourselves.

For instance, we have adapted the grain drill to the planting of all our crops, except corn. The traditional method of sowing oats is to broadcast them into corn stalks and disk them in. Farmers for a long time have recognized that superior results could be obtained by drilling the oats in, and our experiment stations have shown an increase of from 5 to 10 bushels per acre by so doing. However, the drill has never come into general use for sowing oats, because we have never been supplied with a drill which did not clog in corn stalks. After several years of experimentation, in cooperation with engineers of one of the large farm equipment manufacturers, we found a type of drill which would successfully operate in corn stalks. This drill employs a double disk, saw-blade furrow opener 16 inches in diameter, spaced 7 inches and staggered 6 inches. We now use this type of drill for sowing oats, wheat, sweet clover, flax, rye and barley in 7-inch rows and soybeans in 21-inch rows. This drill is also used to apply all of our fertilizer; thus we have what might be called a general-purpose planting tool.

There are, however, numerous improvements which are still necessary on these drills. First of all, we have been able to obtain only a 16-7 drill and we require an 18-7 drill to cover four corn rows when drilling oats in corn stubble. Further improvements could be made in changing the fertilizer feed mechanism to distribute the fertilizer more uniformly. It is also necessary for us to increase the size of the fertilizer and grain boxes in order to complete a round on a field one-half mile wide.

In respect to tillage equipment, we have adapted the heavy field cultivator, employing either spear points or sweeps as our general-purpose tool for the eradication of weeds and for general seedbed preparation, replacing the disk harrow and in some cases even replacing the plow.

We are using our combines as general-purpose harvesters for all crops except corn, and during the past season we even harvested two large fields of corn with combines. The only problem standing in the way of general use of the combine to harvest corn is that of storing shelled corn. Our work seems to indicate that it is quite possible to overcome this difficulty by employing early-maturing varieties of corn and by the use of special ventilated storage bins.

I merely cited these applications as illustrations of what I mean by "general-purpose" implements. It is easy to visualize what standardization on a definite type of grain drill, tillage equipment and harvesting machine would mean, both to the corn belt farmer and to the implement manufacturer. It would mean that power machinery could be sold cheaper, be better designed and approach more nearly in mechanical efficiency and low maintenance cost to the standard of production machines employed in industry. It would mean to the farmer that he would be able to buy cheaper and better machinery, and that his field operations would become simpler. In the light of our experience such standardization is entirely possible and if successfully followed out should lead to increased use of power machinery in the corn belt.

The problems of the corn belt farmer cannot be solved by the application of mass production methods as such, nor by increasingly larger machines. Corn belt farming is more a matter of precision and intensive cultivation. While I believe that the general-purpose tractor, which has so definitely proved itself in the corn belt, can be profitably increased in power in the same way that our automobile engines have been stepped up from 50 to 100 horsepower, I believe that the tractor can, at the present time, be considered the best designed and most efficient piece of machinery we have and that the associated equipment deserves attention first of all in order to bring it up to this same level of perfection and standardization.

A Correction

ATTENTION has been called to the fact that in the article entitled "The Philosophy of Agricultural Engineering," by J. Brownlee Davidson, in the August issue of AGRICULTURAL ENGINEERING, some of the copy was transposed from its proper place, confusing the sense of the article. Beginning at the middle of the second column on page 307, and running well down in the first column on page 308, the paragraphs should read as follows:

As a background to the discussion which is to follow, it might be desirable to quote a conventional and accepted definition for engineering: "The art of organizing and directing men and the utilization of the forces and materials of nature for the benefit of mankind." In other words the engineer is a specialist in labor—the organization and direction of men; in power—the forces of nature; and in materials—the materials of construction and manufacture. Regardless of the branch of the profession to which an engineer may belong, the motive and objective of his work is to utilize labor, power and materials to produce efficiently goods and services to supply human needs; to make life more comfortable, surroundings more pleasant, environment more livable; to facilitate travel, transportation and communication, and to provide opportunity for culture and advancement.

The engineer contributes to these objectives in three ways. One is by doing a thing so well that it does not need to be done over again for some time. For instance, water may be carried from a well to the house in a pail and the requirements for water may be such that the trip to the well and return may be repeated several times in a day. By stretching a pipe, an elongated container from the well to house, with a pump to move the water in the pipe, the container does not need to be moved or replaced. The selection of the right kind and quantity of materials makes the installation permanent.

The second way in which the engineer works is to reduce waste and to make effort more effective. The cleaning of grain, removing weed seed, reduces waste of effort in growing a crop. The building of a hard-surfaced road reduces the waste due to rolling resistance to a wheeled vehicle. Artificial silk has an appeal because it obviates the necessity of looking after silk worms, and the spinning of artificial silk costs less in effort than unwinding raw silk from cocoons.

The third principal field of activity of the engineer is to multiply the output of human effort by the application of power. The process began when early man subdued an animal, perhaps an ox, and tied it to his crude plow. It continued to the present use of fuels and the power of waterfalls. The application of power to conserve labor and increase output is something to cogitate about. Man as a motor is hopelessly outclassed. A strong man can develop about one-eighth horsepower, an insignificant amount when output is desired. A man may travel with his own energy about 2½ miles per hour. With power in an automobile on a good road it is practicable to travel 60 miles per hour, and even 220 miles per hour has been attained. The principal cause for the difference in speed is power.

The output of the worker the world over is directly related to the amount of power utilized per worker. In China most of the workers work without any assistance in the way of a motor. The production under such conditions may be considered unity. In France with the power used per worker it is estimated that the output is increased 8¼ times; in Great Britain, 18 times; and in the United States, 30 times. To use an illustration frequently used, every American worker has the equivalent of thirty slaves at his command.

The utilization of energy has resulted in an enormous output of the worker, and this increase has been the means of advancing well-being. Well-being is here intended to include the worthwhile values of life as well as the prerequisites of comfort, pleasure and happiness.

The Poppelsdorf Mole-Tile Drainage System

By N. L. Wallem[1]

THE rate of progress in various fields of agricultural engineering work is extremely different. In some lines our forefathers have already succeeded, it being necessary only to expand their ideas to fit the beginning of the twentieth century, the machine age. Examples of this are the mechanization of plowing or the complicated process of harvesting grain or any other kind of surface field work. In other lines the world's progress in agricultural machinery is yet in its infancy, in such, for example, as in growing and harvesting truck and row crops or efficient drainage by mechanical means.

A great drawback always in humid regions has been the lack of natural aeration of the soil. Too much moisture prevented the airing process. In many cases only the lack of efficient means of drainage kept the soil from being as fertile and valuable as naturally drained soil. There is no denying the benefit of drainage. Farmers in all humid or semi-humid areas of the world appreciate greatly the necessity and possibility of improving their crops and their fields for future crops by drainage.

Draining the soil is done chiefly by "tile drainage," the best known and most highly developed method of under-draining. The great expense and slowness of installing tiles is considered to be a great obstacle to rapid reclamation of wet land, as capable, when once drained, of producing good crops as any other soil. Various ways have been taken to overcome these obstacles. During the past fifty years they have been tried and developed, yet none of them have become good enough to be considered usable regardless of changing soil conditions. Of course, cutting down the costs and increasing the speed of construction must not be obtained by sacrificing the quality of the work. Both combining timeliness with quality, economy and ability to work under widely varying conditions seems to be accomplished by the combined "mole-tile" drainage method.

The first step towards mole-tile draining was the regular "mole" drainage. This method has long been well known in Europe, and by the end of the last century also in America.

[1]Research assistant, Montana Agricultural Experiment Station. Formerly of the department for the supervision of agricultural engineering research, German Department of Agriculture (Berlin). Assoc. Mem. A.S.A.E.

A tractor with windlass and anchor for pulling a mole and chain of tile

In the beginning, a long time before "tile-drainage" was developed, peasants tried to imitate the mole by using a plow having a vertical knife attached to the frame, at the bottom of which a little barrel-shaped body (mole) was mounted. This, of course, was a very unhandy and inefficient tool. Consequently the tile drainage method in its most primitive stage gained favor and commercial manufacturing of tiles developed slowly.

Only through the idea of using a windlass on tractors was a new incentive given to engineers to develop a practical tractor mole draining equipment.[2] No doubt the windlasses will be developed to a state where every farmer can attach and detach the windlass in a few minutes just as he does his row crop tools. This will be a great step in advance.

Of course there are a number of difficulties to be overcome, as, for instance, the varying shape of the surface and the varying character of the subsoil. If the surface is entirely level or rolling, the gradient must be obtained by adjusting the knife for depth. The subsoil always has to be of a stiff clayey nature in order to insure the staying open of the tunnels; otherwise their walls would break down.

It is further understood that only a small portion of the land necessary to be drained either in Europe or America could be drained by the regular "mole" method. This portion, however, represents a large area and it certainly will pay to use the "mole" wherever it can be used. But there is much other fertile land left to be drained for economical use. From this point of view the regular mole drainage method has its rather narrow limits.

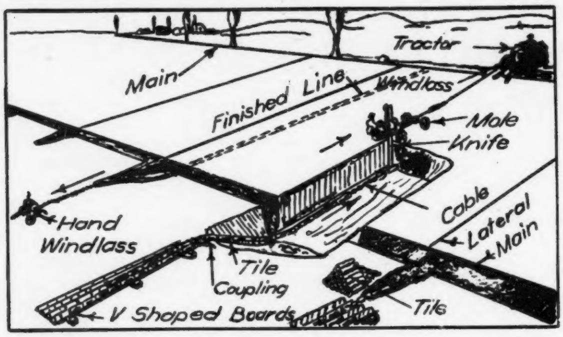
It also is claimed that most mole tunnels give three to ten years satisfactory service, it then being necessary to plow new tunnels. Consequently, the thought of using tiles in connection with moles, the combination of the "mole" and "tile" drainage, came to the minds of agricultural engineers at first in England and Holland. The well-known machine manufacturing company, Fowler, in Leeds, England, tried to solve the problem by the following process: First, the mole was pulled in the original way for about 25 yards; then square holes were dug and a special device for pushing in the tiles or pipes was applied. Professor Visser in Holland, a pioneer in recent mole drainage on the European continent, attached tiles to long boards. These boards were then pulled into the mole tunnels made beforehand. Both the English and the Dutch system failed under ordinary agricultural conditions, yet an efficient method of draining the Zuider Zee has been developed from these experiments, but in this case square-shaped wooden boxes having sharp points in front were drawn in behind the mole instead of tiles.

In order to develop the idea of combining the "mole" and the "tile" method so that it could be applied in agriculture and recommended to farmers, the problem was taken up again in 1928 by Professor Dr. Eng. K. Vormfelde[3] and Dr. Eng. Von Sybel[4] of the Poppelsdorf Department of Agricultural Engineering, Germany. They proposed to use a centering cable for pulling the tiles through

[2]The recent experiences of the Bonn Poppelsdorf Department of Agricultural Engineering (on the Rhine, Germany, the promoter of the Mole-Tile drainage system) in constructing vineyard windlasses, speeded up the job of designing and attaching suitable windlasses for bigger motors and tractors.

[3]Head of the department of agricultural engineering at Bonn Poppelsdorf, near Cologne on the Rhine, Germany. (Landmaschinen-Institute Bonn Poppelsdorf, Rhein, Germany.)

[4]Formerly assistant agricultural engineer at the above-named institution, now professor department of agricultural engineering, University Jena, Germany.



Sketch showing general layout and preparation for mole tiling

the tunnels right behind the mole. As was found out later by them, this method had been tried before in other places (also in America) but with little success. They succeeded by developing a number of auxiliary devices, thus bringing the method to a usable and efficient stage.

The idea of the Poppelsdorf drainage system is briefly as follows: Tiles are lined up on a rope or cable which is connected with the mole and pulled in behind it. After the end of the proposed tile line has been reached by the mole (the tractor with a windlass remaining stationary at the end of the field) the connection between the rope and the mole is released and the rope is pulled out in the opposite direction, while the tiles stay in the tunnels and the mole is wound up to be transported to another line.

Of course it was a long way from the first experiments to the final development of an efficient and reliable outfit ready for use by a farmer or a contractor.

Instead of the original hemp rope, a steel cable was tested and found very easy to handle. But both the ropes and cables could not be used in the great lengths desired because there was no way of laying out and directing a rope 500 feet in length as is often required.

Therefore, the rope with the tiles lined up on them are now laid out in four or five hundred-foot pieces. The operation of lining up the tiles on the cable was simplified by using a long wire needle to be pushed through the necessary number of tiles at once, thus making it possible to pull the cable through the tiles. For keeping the tiles in a straight row for the pulling-through operation, they were laid out in V-shaped channels of the required length made of boards. Exact centering of the tiles on the cable was accomplished only by putting on the cable small sheet iron eggs of the exact size to just fit the inside of the tiles.

In order to couple these 100-foot pieces, a new coupling device has been applied, suitable both for cables and holding-disks. When starting to pull in the first 100 feet, one end of the cable is coupled with the mole while the tiles are held together by a holding disk which is attached at the other end. As soon as the first piece has almost disappeared in the hole, the disk is removed while the next piece is coupled, another disk being attached to the end of the new piece. A very simple construction has been developed for automatic releasing of the cable from the mole when it arrives at the end of the line. The whole cable is then pulled out again by horse or small hand windlass as mentioned above.

For varying soil conditions, the sizes of tiles and the depth and spacing of the tunnels have to be adjusted just as with the regular hand-laid tiles. The first experiments in Germany have been carried out with small lateral tiles of 1½ to 2 inches with a mole of almost 5 inches, a two-plow wheel type tractor with windlass being used. With a correspondingly greater power it undoubtedly will be possible to use larger size moles and tiles for laterals

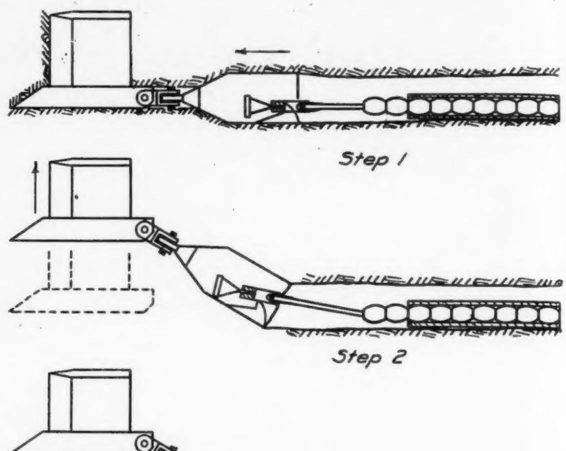


Illustration showing self-releasing action of the mole and tile cable at the end of the line

or mains. In the experiments of the department mentioned, tunnels 400 feet long have been successfully completed, the distance between the lines being 40 feet with a depth of 3.6 feet, and 328 feet of tiles were easily laid in 45 minutes. In an eight-hour working day, with 40-foot spacing, 3280 feet of tiles or 3.2 acres could be laid per day.

The new system of mole-tile drainage costs about 50 per cent of that for hand-laid tile drainage, while regular mole drainage without tiles could be put in at only 20 per cent of the cost of hand-laid tiles.[5] The 50 per cent cent saving is due not only to less labor (by avoiding digging the trenches), but also to mechanizing the laying of the tiles and saving the refilling of the trenches. With a daily capacity of 3280 feet, the costs[6] per foot amount to 2.02 cents[7]. The cost[6] per acre was $20.70[7]. The capacity and corresponding costs will change with the size of tile and the depth and spacing required by local conditions. By the method described in comparison with regular tiling only very little human labor is required for operating the mole-tile draining outfit. Also, as against the regular mole system, light soils can be drained by the new system. Of course, not every soil is adapted even to mole-tile drainage, but the amount of land not suited to it on account of stones, stumps or too coarse gravel is relatively small.

The way the mole tile operation is done assures very close joints between the tiles. The tiles are pulled in under a slight pressure, which, however, is not great enough to crack them. Experts stated that the tiles laid behind the mole were lying better in their tunnels than when laid by hand.

The mole-tile system of draining land makes it possible to utilize tractors more efficiently and to drain about double an area of land at the same expense.

[5]These figures are for German conditions.

[6]Figures based on the plan projected for a certain field, using German labor and prices, transferred into United States money at the rate of 4.20 marks per $1.00. Specified data available.

[7]Including levelling the ground by hand which is sometimes necessary.

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

Investigation of Various Factors Affecting the Heating of Rooms with Direct Steam Radiators, A. C. Willard, A. P. Kratz, H. K. Fahnestock, and S. Konzo (Illinois University Engineering Experiment Station (Urbana) Bulletin 223 (1931), pp. 104, figs. 51).—Studies conducted by the Illinois Engineering Experiment Station, in cooperation with the Institute of Boiler and Radiator Manufacturers and the Illinois Master Plumbers' Association, are reported.

The results show that the steam condensation of a direct cast-iron radiator, expressed in pounds of condensate, is not an adequate measure of the performance of the radiator. The heating effect produced on the air in the room must be taken into consideration in making comparisons between different types of radiators. Long, low, thin cast-iron radiators placed under windows heat a room more comfortably and more economically than higher column or tubular radiators similarly placed. Long, low, thin cast-iron radiators maintain materially better floor to ceiling temperature differentials than high column or tubular radiators.

The larger portion of the temperature differential in a room heated with direct steam cast-iron radiators of the column and tubular types occurs between the floor and the breathing level. The temperature used as an indication of whether a room is properly heated or not should be observed at some level nearer the floor than the breathing level. A 30-inch level is tentatively suggested as more representative of conditions in the zone of human occupancy.

The use of a properly designed inclosure or shield on a tubular or column type of radiator results in a gain in steam economy and equally or more satisfactory air temperature conditions in the room, as compared with those obtained by the use of the same radiator uninclosed. The used of an improperly designed inclosure on a tubular or column type of radiator results in a reduction in steam condensation and in unsatisfactory air temperature conditions in the room, as compared with those obtained by the use of the same radiator uninclosed.

A properly designed inclosure or shield should offer a minimum of resistance to the flow of air over the radiator under gravity head, and should protect the wall back of the radiator against the effect of direct radiation from the radiator. It should have the top of the opening in the face of the inclosure as high as possible and permit free access of air over the lower half of the radiator, especially near the floor. No material gain in economy or room temperature conditions may be realized from the use of an inclosure or shield on a wall type of radiator. Increasing the size of an inclosed or an uninclosed radiator results in a uniform increase in the room temperature at all levels in the room, and an increase in the steam condensation. The steam condensation, however, increases at a greater rate than the increase in indoor-outdoor temperature difference, and it is not safe to predict the steam condensation for one size of radiator from the room temperature gradient curves and steam condensation for another size. Both steam condensation and room air temperature conditions are affected by the location of the heating unit. In general the location under a window in the exposed wall is to be preferred to a location near an unexposed or warm wall. The location near the ceiling is a most unfavorable location for a radiator and is not to be recommended.

Painting a radiator or inclosure with an oil paint, irrespective of the color of the paint, has no material effect on the heat transmission as compared with that for foundry finish or oxidized iron. Galvanizing or painting with metallic bronze paint reduces the heat transmission from an inclosed or uninclosed radiator below that obtained with oil paint. The reduction is approximately 9 per cent in the case of uninclosed tubular or column radiators.

The use of an inclosure having clearance between the radiator and the back of the inclosure reduces the temperature of the wall surface back of the radiator approximately 45 F below that obtained with an uninclosed radiator. The use of an inclosure with a galvanized back, or one painted with metallic bronze paint, reduces the temperature of the wall surface back of the inclosure from 10 to 25 F below that obtained with an inclosure with the back painted with oil paint. In this respect galvanizing is slightly more effective than gold or aluminum bronze.

The use of storm sash alone does not materially affect the room air temperature conditions, but did effect a gain in steam economy of approximately 11 per cent in the particular room tested. The use of a storm door alone improves room air temperature conditions, and in the particular room tested effected a gain in steam economy of approximately 21 per cent. The use of both storm door and storm sash improves room air temperature conditions, and in the particular room tested effected a gain in steam economy of 31.7 per cent. The actual saving in general will be dependent on the ratio of window and door area to exposed wall area and on the air tightness of the storm door and sash.

Variations in basement and attic temperatures do not have a material effect on room air temperature conditions. Variations in the amount and arrangement of the exposed walls may have a very material influence on both room air temperature conditions and steam economy. The degree of comfort experienced by the occupants of a room is greatly influenced by the temperature of the inner surface of the walls as well as by the temperature of the air in the room.

The temperature of the inside surface of exposed standard frame walls varies from 67 to 59 F for walls not exposed to air movement and from 65 to 53 F for walls exposed to an air movement of approximately 10 miles per hour as the outdoor temperature ranges from 40 to —10 F and the indoor temperature remains constant at 72.5 F. The temperature of the inside surface of single pane glass without storm sash, and with an outdoor temperature of —2 F, is approximately 33 F when not exposed to air movement and 17.5 F when exposed to air movement of approximately 10 miles per hour. The temperature of the inside surface of the inside glass pane when storm sash is used and with an outdoor temperature of —2 F is approximately 52 F when not exposed to air movement and 41 F when exposed to air movement of approximately 10 miles per hour.

The use of curtains and shades does not materially affect the room air temperature conditions and steam economy, but does serve to increase the degree of comfort of the occupants by shielding them from radiation to the cold glass surfaces.

Note on Research Work Done by the Special Irrigation Division Since Its Formation in June, 1916, C. C. Inglis (Bombay Publis Works Department, Technical Paper 28 (1929), pp. [4] + 36, pls. 2, figs. 36).—This is a summary of the important points of several lines of hydraulic research conducted during the past 15 years by the Irrigation Division.

Engineers Seek Best Terrace Plans, R. W. Baird and H. J. Harper (Oklahoma Station (Stillwater) Report 1927-1930, pp. 280-282, figs. 2).—The progress results of terracing studies are reported which indicate that terrace ridges can be constructed cheaper with a crawler type of tractor and grader than when a wheel tractor is used.

The percentage of run-off does not vary appreciably when a 2, 3 or 4-foot vertical interval is used between terrace ridges. The rate of rainfall and moisture content of the soil affect the percentage of run-off for a given rain. Variations from less than 20 to more than 65 per cent have occurred from similar heavy rains.

The amount of run-off water increases with the fall, or gradient, of the terrace ridge, and where the gradient exceeds 4 inches per 100 feet, considerable quantities of sand are carried along the causeway by the run-off water. The total sediment carried away in run-off water from the area bounded by a terrace ridge having a gradient of 4 inches per 100 feet is less than 2 tons of soil per acre per year. This rate of erosion is less than 5 per cent as rapid as that which occurred on an adjacent area of unterraced land.

The temporary ground water level is usually higher on the terraced land than on unterraced land during the spring months when the rainfall is greater than at other periods during the year.

Harvesting Cornstalks for Industrial Uses, J. B. Davidson and E. V. Collins (Iowa Station (Ames) Bulletin 274 (1930), pp. 373-394, figs. 18).—Investigations are reported which were conducted partly in cooperation with the Iowa Engineering Experiment Station.

The results show that the development of industrial uses for cornstalks is dependent, in large measure, upon an adequate supply of raw material at a reasonable cost. Cornstalks, being light and bulky, are difficult to handle, and economical harvesting is essentially a problem of reducing labor. The yield of cornstalks (15 per cent water content basis) varies from 1 to 2 tons per acre. Dry, wind-blown stalks in Iowa may be expected to yield from 0.5 to 1.5 tons per acre. Cornstalks can not be harvested economically by hand. Harvesting with corn binder, husker-shredder, and baler costs about $7 per ton under average conditions. Harvesting by breaking, raking and baling in the field is a very practicable method, and the cost for average conditions is about $3.55 per ton. Under favorable conditions the cost may be $2.70 or less per ton. Combination machines, consisting of mower, rake and baler, reduce labor. The harvesting of 236.8 tons at Ames in 1930 cost $2.49 per ton exclusive of machinery costs. A reasonable estimate of the cost of machinery, exclusive of power, is 50 cents per ton.

The cost of collecting baled stalks in the field, transporting

them 8 miles and unloading is about $1.80 per ton. Collecting 236.8 tons of stalks at Ames, hauling them to the station, 1 to 4 miles and unloading into cars cost $1.23 per ton. Cornstalks when baled without shredding do not absorb water so readily and tend to store better when piled. The capacity of the baler, however, is increased if the stalks are shredded and the weight of bales is increased. The cost of piling cornstalks was 35 cents per ton with an inclined elevator.

[Agricultural Engineering Investigations at the Iowa Station] (Iowa Station (Ames) Report 1929, pp. 11, 12).—Studies on the practicability of waterproofing a masonry arch roof indicated the feasibility and utility of pointing up all open joints with rich mortar, painting each concrete rib with neat cement wash, and painting the entire roof with two coats of raw linseed oil.

A study of nearly 100 cows showed a rather definite relationship between the weight of the cow and the length of stall platform necessary. By dividing the weight of the cow by 50 and adding 36.5 inches to the quotient, one can very closely approximate the proper stall length from the center of the manger curb to the gutter.

Data also are briefly reported on the cost of corn production.

Farm Water Power, G. M. Warren (U. S. Department of Agriculture, Farmers' Bulletin 1658 (1931), pp. II + 22, figs. 20). —This bulletin supersedes Farmers' Bulletin 1430. It describes and illustrates a number of typical farm water-power plants and gives practical information on their planning, installation and maintenance.

New Jersey Brooder House or Small Laying House, J. C. Taylor and E. R. Gross (New Jersey Station (New Brunswick) Hints to Poultrymen, 19 (1931), No. 5, pp. 4, figs. 5).—Practical information is given on the construction of this house, together with working drawings and a bill of materials.

[Agricultural Engineering Investigations at the Indiana Station] (Indiana Station (LaFayette) Report 1930, pp. 8-14, figs. 4).—In the corn borer control studies plow coverage tests, made to determine the cornstalk coverage ability of different size plow bottoms and the value of trash wires or shields and large coulters and jointers plowing at a depth of 7 inches, gave a coverage of 99.101 per cent with 14-inch-bottom plows, 99.265 with 16-inch plows, and 99.286 per cent with 18-inch plows. At a depth of 8 inches the 14-inch plows gave a coverage of 99.46 per cent, the 16-inch plows 99.536, and the 18-inch plows 99.475 per cent. A check made with the same types of plows without trash wires or shields and the regular coulters and jointers plowing at a depth of 7 inches gave a coverage of 95.16 per cent, or left 6.18 times as much trash exposed as when these special devices were used. The use of electric current to kill corn borers in either growing or dry stalks did not seem practical because of the high resistance of the borer and the very poor conductivity of either green or dry stalks.

Low cutting attachments for combines for harvesting soybeans were found to reduce the cutter-bar losses in proportion to the lowness of cutting. In order to reduce cutting losses to a minimum without causing other serious handicaps, a combine should be able to cut soybeans 2 inches above the ground on level land. The use of windrow and pick-up attachments in harvesting soybeans increased the loss of beans. The soybeans did not cure well in the swath because the stubble was too short to support the swath off the ground. Windrow and pick-up attachments were found to be satisfactory for harvesting wheat, but unless weed or clover growth was unusually rank windrowing was not necessary for satisfactory combining of wheat.

The use of insulation and ice in one room of the partially below ground apple storage at the Moses Fell Annex farm near Bedford reduced temperatures from 5 to 14 F below those in the air-cooled room. It was possible to maintain the temperature in the iced room below 50 F. The greatest difference in temperature between the two rooms was during the warmest weather. Grading of Grimes and Jonathan apples in storage from September 16 to December 16 showed 4 per cent more sound fruit in the iced room than in the air-cooled room. The relative humidity in the iced room remained very close to 90 per cent, which was approximately 10 per cent higher than that of the ventilated room. Both Grimes and Jonathan shriveled more quickly in the ventilated room than in the iced room. Smoke tests showed a complete air change every 5 minutes in each room when the exhaust fans were operated. The cost of ice and electricity was 14 cents per bushel in 1929-30 as compared with 18 cents in 1928-29. Before the room was insulated the cost was 23.5 cents per bushel in 1925-26 and 26.9 cents in 1926-27.

In the terracing studies on the Paoli field no noticeable erosion took place in terrace flow lines with grades as steep as 0.7 feet per hundred feet when the field was in clover and timothy sod. When in wheat, erosion took place in flow lines with a fall of over 0.5 feet per hundred feet. When the field was in corn some erosion took place in terrace flow lines with a fall of over 0.4 feet per hundred feet. When the grade of the flow line was less than 0.3 feet per hundred feet, there was not sufficient grade to keep the flow line clear of the soil which washed into it from between terraces. In sections in which corn rows crossed the terraces it was necessary to clean out the flow lines with shovels.

In poultry housing studies 4 years' results showed no definite benefits in winter of long-time egg production arising from the use of insulation or special ventilation devices. Although extreme drops in outside temperature were not accompanied by as severe changes in the insulated houses as in the uninsulated pens, there was very little difference in egg production. Pen temperatures maintained above 40 F by means of artificial heat did not increase egg production. Birds confined in an open-front house maintained egg production until April, but after that laid less eggs than did birds permitted to go outside each day. The mortality also increased among the confined birds.

In grain and hay drying tests hot air blown through freshly cut alfalfa on false bottoms in large sheet-iron tanks dried the hay at the rate of 400 pounds of dry hay per hour. The hay was cut and blown into the tank with a silage cutter. This recut hay packed together readily and required stirring to permit the air to pass through it and carry off the moisture. The same equipment was satisfactorily used for drying wheat which had passed through the hot water treatment for smut. Three thousand bushels of river bottom corn were dried in the crib by forcing heated air up through an air distributing tunnel, 2 feet wide and 2.5 feet high, built through the middle and extending the full length of the crib. The corn, as it came from the field, contained from 60 to 70 per cent of moisture in the cob and from 30 to 40 per cent in the grain. After treatment the grain contained 18 per cent and the cob 30 per cent of moisture. The cost of fuel and labor was 3 cents per bushel.

In studies of uses of electricity the use of a 10-hp motor to drive a 20 by 32-inch thresher was shown to be satisfactory for threshing wheat, oats and soybeans. Records of electric brooders operated on Indiana farms in 1929 and 1930 during April, May and June indicate that fuel costs for electricity at 3 cents per kilowatt hour may be considerably less than for hard coal at $16 per ton. This difference is largely attributable to the practice of cutting off the current to the brooder on warm days. Brief data also are given on the cost of milk cooling with electric refrigerator, power cost for stationary spray plant, and cost of grinding oats.

[Agricultural Engineering Investigations at the Iowa Station] (Iowa Station (Ames) Report 1930, pp. 9-11).—Studies in the waterproofing of the tile roof of a masonry arch barn indicated the value of an asphalt paint of a sufficiently high melting point to resist the heat of the sun. Although fiber paints proved satisfactory, they are expensive. The cost of roof treatment with asphalt and aluminum paints is reasonable, the cost of the material being approximately $2.50 per square (100 square feet).

In studies of stall floors for dairy barns over a period of 10 years, it was found that the bituminous concrete type failed completely, the concrete and rubber type showed little or no wear, bituminous floors laid over concrete and tile showed considerable distortion and required replacing, and cork brick and wooden block resisted wear but were not satisfactory from a sanitary standpoint.

Tests of a fan system of mechanical ventilation for dairy barns driven by electric motors indicated that such a system has much merit where a reliable source of electric current is at hand. The control of ventilation is much more positive than where the rarefaction of air due to heating is used to induce circulation for ventilation.

Brief data also are presented on cost of creamery buildings, harvesting corn stover for industrial purposes, and labor and power costs of corn production.

Electrifying the Kerosene Incubator, O. E. Robey (Michigan Station (East Lansing) Quarterly Bulletin, 13 (1931), No. 3, pp. 114, 115, fig. 1).—The results of tests are briefly reported on the use of electricity to heat incubators designed to operate on kerosene. It was found that electricity at 3 cents per kilowatt hour will cost about 1.5 cents per day more than kerosene, but this will probably be more than offset by the reduced fire risk and the lesser amount of care required.

Following Combustion in the Gasoline Engine by Chemical Means, L. Withrow, W. G. Lovell, and T. A. Boyd (Industrial and Engineering Chemistry (Washington, D. C.), 22 (1930), No. 9, pp. 945-951, figs. 11).—Investigations are reported in which measurements were made of the oxygen concentration in gases withdrawn from the cylinder of a gasoline engine with a new and improved sampling valve. This valve was located at different places in the combustion chamber and opened at different times during the combustion of the charge.

Under the conditions defined the combustion process in the gasoline engine consists of a narrow combustion wave which proceeds from the spark plug through the combustion chamber at a finite rate. The combustion zone travels at a greater rate and follows a different type of acceleration curve through the middle portion of the combustion chamber than along the side walls. Over the range investigated the average speed of the combustion zone increases with the engine speed. The progress of the combustion zone is unaffected by a change in spark timing or by the addition of sufficient lead tetraethyl to the fuel to stop detonation until after it has traveled the greater portion of the distance across the combustion chamber. The disturbance which is known as the knock or detonation is confined to that part of the charge which burns last.

Sprayer Accessories Affect Efficiency of Equipment, G. R. Starcher (Michigan Station (East Lansing) Quarterly Bulletin,

13 (1931), No. 3, pp. 147-152, fig. 1).—This is a condensed report of the results of studies to determine the relation to pressure loss and to delivery from the nozzle of variations commonly found in several of the accessories necessary in spraying operations. Included in these are hose, hose fittings, cut-offs, rod parts, and gun and nozzle disks. All tests were made on a sprayer equipped with a three-cylinder pump with a rated capacity of 16 gallons per minute. The pump was operated with a 5-hp electric motor which was substituted for the usual gasoline engine. Tap water was used for all tests. A standard, single nozzle spray gun was used in most of the work, though for certain of the studies multiple nozzle rods were substituted. Pressure gauges of the type usually furnished on sprayers were used, and were calibrated from 0 to 600 pounds in units of 10 pounds.

It was found that with equal pressures at the gun increasing the disk aperture gives an almost equally uniform increase in delivery at each pressure. The increases are greater at high than at low pressures. The increase, however, is less than the proportional increase in the area of the aperture. Doubling the diameter slightly more than doubles the delivery, and as the aperture is gradually increased there is a slightly more rapid increase in delivery.

Uniform changes in pressure gave equally uniform changes in delivery. Increasing the pressure at the gun from 200 to 400 pounds with disk apertures of 4, 6, 7, 8, 9, 10, and 12 increased the deliveries 43, 42, 43, 45, 45, 43, and 44 per cent, respectively. The delivery and pressure at the gun with hose of small diameter, when the disk aperture and pressure at the pump are uniform, may be much less than with hose of large diameter.

The substitution of hose fittings with large openings for the so-called ordinary fittings with small openings makes a marked difference in pressure loss and consequently in delivery with ⅝ and ½-inch hose, but less difference is noticeable with ¾-inch hose with deliveries up to 16 gallons per minute. For equal pressures ⅝-inch hose with large fittings is as efficient as ½-inch hose with ordinary fittings, and ½-inch hose with large fittings approaches ¾-inch hose in efficiency. No significant differences are shown between the two types of fittings on ¾-inch hose. Under certain conditions it is possible to substitute the lighter and less expensive hose for the larger and heavier hose, provided fittings with large openings are used.

It was found that the length of the hose, up to 50 feet, was not so significant in reducing pressure as the type of fittings used. A comparison of 50 and 12.5 feet of ⅝-inch hose showed that the reduction of 75 per cent in length reduced the pressure loss from about 25 to 30 per cent with both ordinary and large fittings.

A rod with 4 nozzles will not deliver quite 4 times as much liquid as a single-nozzle gun with a disk with the same aperture as those used in the rod. There is more friction in the rod than in the gun because a rod which delivers the same volume of spray as a gun requires greater pressure. All cut-offs were efficient so long as used on the types of rod for which they were intended. A small cut-off is satisfactory on a rod with three or four nozzles, but larger cut-offs are desirable for six and eight-nozzle rods. The number of holes in the nozzle whirl plates affects the delivery from the nozzle. A plate with 4 holes offers greater resistance than one with six holes and the number of holes has a marked effect on the pattern of the spray. A more spreading type of spray which will travel a shorter distance is formed with the four-hole whirl plates.

Experience with Buildings [trans. title], B. von Arnim (Arbeiten der Deutschen Landwirtschafts-Gesellschaft fur Osteneich (Vienna and Leipzig), No. 376 (1930), pp. 103, figs. 86).—This is a handbook of general information on farm building construction based on experience in Germany. It contains sections on building materials; roofs; towers; stalls for cows, calves, swine, horses, and colts; poultry houses; implement shelters; ice houses; dwellings; and fire protection.

Flow of Ground-Water as Applied to Drainage Wells, M. R. Lewis (American Society of Civil Engineers (New York) Proceedings, 57 (1931)), No. 3, pp. 411-423, figs. 8).—In a contribution from the Oregon Experiment Station and the U.S.D.A. Bureau of Public Roads, three types of wells are discussed, including artesian wells (not necessarily flowing) with a perforated casing extending through the water-bearing stratum, wells in which the water table is in the water-bearing stratum and which penetrate its full depth, and open-bottom wells, that is, wells which just reach the water-bearing stratum.

Cases in which the zone of influence is either definite or indefinite are considered for each type, and formulas for the draw-down curves of each of these types of wells are derived. The conclusion is drawn that if the area to be drained is more than a few hundred feet in diameter, successful drainage will depend on a general lowering of the water table. To secure this lowering, wells should be designed to have the greatest possible capacity with an economical lift. Such capacity may be secured most readily, where conditions are favorable, by deep wells.

Home Grown Timbers—Their Anatomical Structure and Its Relation to Physical Properties: Elm, S. H. Clarke ([Great Britain] Department of Science and Industrial Research (London) Forest Production Research Bulletin 7 (1930), pp. VI—27, pls. 12, figs. 7).—The anatomical structure of the secondary wood of **Ulmus campestris, U. major, and U montana** is described, and the range of variation in the material under examination is given in the form of tables and graphs. The maximum size of the elements is greatest in **U. major** and least in **U. montana.** During the youthful period the elements become progressively larger; in the adult period their size is relatively constant. Wood formed in youth is generally denser than wood formed during the adult period, irrespective of ring width.

The relations existing between structural features are usually complicated, as in the case of ring width and the proportion of summer wood. A simple relation, however, exists between specific gravity and fiber volume. The relations between strength and specific graviety and between strength and fiber volume are of about the same order. The correlation coefficient in each case is low ($+ 0.279 \pm 0.096$ and $+ 0.266 \pm 0.096$ in **U major**). The correlation between strength and the proportion of fiber wall is somewhat closer ($+ 0.349 \pm 0.103$ in **U. major**), and between strength and the combined proportions of primary and secondary walls is closer still ($+ 0.436 \pm 0.085$ in **U. major** and $+ 0.572 \pm 0.090$ in **U. montana.**)

The Influence of Turbulence Upon Highest Useful Compression Ratio in Petrol Engines, T. F. Hurley and R. Cook (Engineering [London], 130 (1930), No. 3373, pp. 290-293, figs. 10; abs. in Sci. Abs., Sect. B—Elect. Engin., 34 (1931), No. 397, pp. 4, 5).—Studies are reported which dealt with the promotion of different types of turbulence and the examination of the movement obtained while motoring the engine, and with the highest useful compression ratio resulting from the employment of the various types of turbulence observed. Experiments were made on a Ricardo variable compression, sleeve-valve engine of 2⅞-inch bore and 3¼-inch stroke. Any desired direction was given to the entering air by placing in the ports, near the sleeve, groups of thin curved parallel vanes. The motion of the air was deduced from observing the movement of sparks of burning material admitted with the air, by inspecting, the movement of an oil film on the underside of a glass window inserted in the cylinder head, or by observing the movement of drops of water introduced into the entering air.

Photographs of the observations indicate that a rotational swirl once initiated tends to persist throughout the cycle. Admission through a single port induced swirling about a vertical axis, and eddying turbulence was only observed when the air entered in two opposed streams, but was still accompanied by some degree of rotation. Evidence was obtained of the existence of an axis of low pressure in the cylinder. The highest value of the highest useful compression ratio was obtained with the air entering in an undisturbed tangential flow and was accompanied by a regular combustion knock, distinct from detonation, which was more or less observable throughout the tests; the lowest value occurred with eddying or indiscriminate turbulence.

A theory is advanced for the process of combustion which, if correct, would indicate that combustion chamber design should be modified so that part of the mixture near the sparking plug remains stagnant or in a state of indiscriminate turbulence, while the main body of the charge is given a definite unidirectional swirl.

Construction Joints in Concrete.—Bonding New Concrete to Old, N. Davey ([Great Britain] Department of Science and Industrial (London) Research, Building Research, Special Report 16 (1930), pp. VI + 74, pls. 10, figs. 6).—The results of experiments on the making of construction joints in concrete and their subsequent behavior are reported.

Part I of the report deals with the details of the experimental procedure and Part 2 deals with the evils attending the improper construction of joints. Part 3 discusses the factors reducing the efficiency of bond at construction joints, among which are segregation and the formation of laitance, scum, dirt, and clay arising from the use of unclean materials, and oil and grease deposited from the mixing plant and tools.

Part 4 is concerned with the preparation of the surface of the old concrete for bonding on the new concrete. It is concluded that the best method of treating the old surface of matured concrete resulted from bushhammering and wire-brushing. Immature concrete did not give such good results by this treatment. The use of certain proprietary solutions for treating the surface of concrete was found to be advantageous. The bond strength was generally higher with less matured concrete than with thoroughly matured concrete. Washing the surface of cement concrete with dilute hydrochloric acid to produce a key for the new concrete did not produce very good results.

The method of application of the new concrete to the prepared surface of the old concrete is dealt with in Part 5. It was found that to insure a good bond a mixture must be used which is sufficiently plastic to enter the interstices of the surface of the old concrete. The durability of construction joints is discussed in Part 6.

Part 7 is concerned with the bonding of different types of cement. There appeared to be no objection to bonding on new concrete prepared with a different type of cement. The adhesion of normal portland cement concrete to aluminous cement concrete was only approximately 80 per cent of the adhesion of normal portland cement concrete to the same material. The bond of rapid-hardening portland cement concrete to normal portland cement concrete appeared to be slightly better than the bond of rapid-hardening portland cement concrete to the same material.

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It is in keeping with this spirit for ASAE members, in talking with others whom they believe should apply for membership, to call attention to the direct personal values of membership. We like best to see men submit their applications out of a sense of common interest in the welfare of the profession. But many are now so busy meeting immediate personal obligations that they have to forgo helping good causes and making investments which bring only indirect returns. Invite them to consider applying for membership, from the standpoint of its possible direct value to them, as carefully as they are considering any other action which involves use of their money.

Every ASAE member knows that much agricultural engineering information is first made public at meetings of the Society or in AGRICULTURAL ENGINEERING. No one of them is in a position to use all of this information profitably. But the member is rare who is unable to apply any of it to his particular problems. Most every one of them uses ideas and suggestions which reach him through his membership in this Society to such an extent, so closely tied in with his own experience and originality; and with results that keep on repaying him for such an indefinite period of time that he cannot measure the value of the information the Society furnishes him.

Membership also gives him a point of contact with the leaders in the agricultural engineering profession which may be of direct benefit in many ways. In many cases it gives needed inspiration to more productive work. It offers, in fact, a continuation of professional training under the combined agricultural engineering educational leadership of all the colleges and universities. It brings individual achievement to light and gives it wide recognition. The resulting mutual acquaintance and understanding leads to the formation of satisfactory business and professional connections, and to merited promotions.

If more need be said, it can be, in that the Society headquarters is a veritable clearing house of information and service to its members.

We are proud to say that membership in the American Society of Agricultural Engineers is justifying itself to men who have any connection with this field, from the standpoint of value received. In these times of unusually careful value-watching in both spending and investing, the membership of this Society is still growing. Applications are coming in at the usual rate, but we submit as even more significant the fact that the Society's membership turnover continues small. Its present members, who have tested the value of membership over periods of from one to twenty-five years, are mostly keeping their annual dues paid up.

Cost and Value of Machines in Farm Production

FARM management men of the University of Georgia have obtained and published[1] data on the cost and utilization of farm machinery in that state, taking into consideration the specific kinds and numbers of farm machines used on the farms studied, the sizes of farms, whether operated by horses or mules, and the separate cost factors involved.

A particularly interesting comparison is drawn between the ten farms highest and the ten lowest in acreage per man, which is decidedly enlightening, and incidentally favorable, from the standpoint of net and labor income, to the higher acreages per man.

But to bring out the full value of these figures, more data are necessary. No data are furnished on the influence on gross, net and labor income per farm of each individual item of equipment. We appreciate that such data will be difficult to get, but it is important and worth making an effort to secure. Cost is only one side of the question. Without knowing, as well, something about the earning power of each, or more accurately, its importance to the earning power of his whole production program, how is a farmer to intelligently decide between buying a new plow, drill, cultivator, feed grinder, or perhaps more land or fertilizer? How can he develop an efficient, balanced production program without knowing the relative weights of the several factors involved?

Data on what tractors, disk harrows, weeders, ensilage cutters and each other item of farm equipment can contribute to the net income of a farm under specific combinations of contingent factors must be made available. Here is a real problem in production economics for agricultural economists, engineers, or who can solve it.

New Triple Alliance

AGRICULTURAL engineering, farm management, and agricultural economics forming a three-power alliance in the field of research, is the pre-vision one agricultural engineer has suggested to us as a probable actuality of the near future. He sees the trio and their capacity to lower production costs gaining the recognition and support of men of considerable influence in the agricultural world.

A good example of what this triad can do is shown in the accomplishments of the Collins Farms Company. Arthur Collins in an article in this issue brings this point out incidentally. From beginning to end his story is one of a corn belt farm manager securing the cooperation of agricultural engineers and using engineering products and principles in solving his particular economic problems.

Managing 30,000 acres of Iowa land, in units of 500 to 1500 acres, studying costs while foremen attend to the routine of detailed management and operation which swamps the individual farmer, Mr. Collins has developed some principles and practices of economical mechanization which are equally applicable to other corn belt farms the size of his individual units.

One of his substantial economies is low per-acre invest-

[1]Georgia State College of Agriculture, Extension Bulletin Vol. XX, No. 407.

ment in equipment, achieved by using general-purpose, high-load-factor machines. He uses mostly 10-20 general-purpose tractors and would like to have bigger ones which would pack half again as many horsepower and only involve about $200 additional investment. He uses combines exclusively for harvesting small grains, keeping them busy almost continuously from the time wheat harvest starts in the middle of July until soybeans are harvested some time in October, and has also tried them with some success in harvesting corn. After several years of experimenting, in cooperation with the agricultural engineers of one of the implement manufacturing companies he has developed a general-purpose drill with which he plants all of his crops except corn. He uses heavy field cultivators with spear points and sweeps for killing weeds and preparation of seedbeds, replacing the disk harrow and, to some extent, the plow. He has kept his machinery investment below $7.00 per acre and his calculated depreciation of 10 per cent on this investment amounts to only about 8 or 9 per cent of his cost of production. And he is looking forward to further economies as agricultural economists and agricultural engineers join with farm managers to face together the problem of farm production costs.

With even a few leaders in all three of these fields enthusiastic over the possible achievements of their united research efforts, these seem assured of a far more extensive trial than they have yet had.

Farmers and New Ideas

IF WE are sometimes impatient with the rate at which American farmers adopt improved methods and equipment we may console ourselves with the thought that English farmers are even slower.

Three Englishmen, including J. E. Newman (Mem. A.S.A.E.) spent several months last year studying, as an official delegation, the application of farm equipment in Canada and the United States. Their report is the subject of much comment in "The Implement and Machinery Review" (London). Says the Review, in part, "Judging by this report, British farmers seem to have toyed, to a great extent, with the mechanical facilities that have been produced for their benefit, whereas the Canadians and Americans have adopted them with enthusiasm, or at least with a healthy inquiring turn of mind, and it is this difference in regarding the subject, and perhaps nothing more, which has led to Canadian and American farms being so highly mechanized and run on a low-cost basis, while English ones are still operated on traditional lines that are not in keeping with the times. The report, to be perfectly candid, is more an indictment of the unreceptivity of the British farmer to totally new ideas, particularly mechanical ones, than it is anything else."

Agricultural Engineering Anthology

IN THE articles which appear in this Journal, and in other addresses and writings of agricultural engineers and their associated workers, are occasional phrases, sentences and paragraphs which, in addition to their connection to the work as a whole, are independent gems of thought. As fresh viewpoints, or new clarity of expression on old subject matter; and as the vapor of nascent ideas on new developments distilled from disciplined imaginations, they radiate vitality. But in their respective places in complete works their independent values may easily be overlooked by many. For that reason we plan to set them out for special attention, so far as space permits, with or without supplementary comment. We submit them neither as incontrovertible truth nor as the viewpoint of the American Society of Agricultural Engineers, but for what they may be worth to other agricultural engineers as nourishment for the conscious and subconscious mind, as a growing ration for philosophy, or as a tonic for languishing inspiration and ego.

* * * * *

"An agricultural engineer may be described briefly as a man who devotes his knowledge of engineering principles and application to solving the technical problems of agriculture. He must be acquainted with all the sources of information concerning the various fields of organized agricultural knowledge, and be able to translate the information gained from these fields into engineering terms and realities. He should be the connecting link between the great industry of agriculture and the profession of engineering."—L. J. Fletcher

* * * * *

"Modern machinery is not tending to eliminate the family-operated farm, but on the other hand, is giving the farm family the opportunity to demonstrate its ability to meet changed conditions and continue as the best form of farm organization for economic production, as well as social welfare."—L. J. Fletcher

* * * * *

"The requirements of sanitary milk production and the conditions necessary for comfortable and hygienic housing of cows are in many respects antagonistic. . . . . A recognition of these facts leads to dairy barn designs featuring separate milking room and housing quarters, which may develop into two separate structures."—J. D. Long

* * * * *

"Closer contact between the oil and tractor industries, as well as within the tractor industry itself, could be established and maintained with benefit to all concerned."—A.S.A.E. Committee on Fuels and Lubricants

* * * * *

"The most desirable qualities in a research worker may be listed as (1) vision, (2) perception, (3) imagination, (4) sound judgment, (5) technical skill, and (6) ambition. . . . . It is to the graduate schools of our best universities that we must look for the education of research workers of the future. In these are found the libraries and the literature that link the present with the past and point the way to the future. In these also are most likely to be found the men of science with vision and perception who can. . . . . . . stir the imagination of youth. And that, you are reminded, is a first step in preparation for a career in research."—Dr. Andrew Boss

* * * * *

"It is not the problem of this Society to design rural electric lines. It should, rather, see that its engineers go deeply into the future, not two, three or five years, but ten or fifteen years hence and determine what the farmer is going to do with electricity on the farm, what we are offering to reduce the farmer's financial burden, to reduce his physical labor and to permit him to increase his production at a lower cost per unit."—C. P. Wagner

* * * * *

". . . . . . The greatest economies which can be brought about in the immediate future can be obtained by giving more attention to the tools and equipment which are associated with the general-purpose tractor and by more specifically adapting them to corn belt conditions."—Arthur Collins

* * * * *

"The rate of progress in various fields of agricultural engineering work is extremely different. In some lines our forefathers have already succeeded, it being necessary only to expand their ideas to fit the . . . . . machine age . . . . . In other lines the world's progress in agricultural machinery is yet in its infancy, in such, for example as in growing and harvesting truck and row crops, or efficient drainage by mechanical means."—N. L. Wallem

A.S.A.E. and Related Activities

Tentative Program

A.S.A.E. POWER AND MACHINERY DIVISION MEETING

The Stevens Hotel, Chicago, Illinois
November 30 and December 1, 1931

First Day — Monday, November 30

Forenoon Session—9:30 to 12:00

1. PAPER: "Intra-Field Transportation of Agricultural Machinery" (Speaker to be selected)
   Discussion led by J. R. Taylor, farm management specialist, Caterpillar Tractor Company
2. PAPER: "Farm Production Costs as Affected by Mechanical Farm Equipment," by Dr. C. T. Holmes, division of farm management and costs, Bureau of Agricultural Economics, U. S. Department of Agriculture
3. PAPER: "Mechanical Manipulation of Soil as It Affects Structure," by John A. Slipher, assistant professor of soils, Ohio State University

Afternoon Session—2:00 to 4:30

1. PAPER: "Trends in Design of Power-Operated Machinery" (Speaker to be selected)
2. PAPER: "Diesel Engine Design for Tractor Service," by C. G. A. Rosen, Diesel engineer, Caterpillar Tractor Company
3. PAPER: "Factors Affecting the Economic Use of Tractor Engines at Part Loads," by E. G. McKibben, agricultural engineer, Iowa State College

Evening Session—7:30 to 10:00

1. Council Meeting
2. Committee and Group Round Tables
   (a) Committee on Row Crow Equipment (R. I. Shawl, chairman)
   (b) Committee on Combine Development (E. G. McKibben, chairman)
   (c) Committee on Feed Mill Rating (E. A. Silver, chairman)
   (d) Other round table sessions to be arranged on request

Second Day — Tuesday, December 1

Forenoon Session—9:30 to 12:00

1. PAPER: "The Characteristics of Feed Mill Performance," by E. A. Silver, agricultural engineer, Ohio State University
2. PAPER: "Progress in Developing Machinery for Beet Production," by E. M. Mervine, agricultural engineer, U. S. Department of Agriculture
   Discussion led by C. T. Lund, American Beet Sugar Company

Afternoon Session—2:00 to 4:30

1. SYMPOSIUM: "Grain and Forage Crop Drying"

Tentative Program

A.S.A.E. STRUCTURES DIVISION MEETING

The Stevens Hotel, Chicago, Illinois
December 1 and 2, 1931

First Day — Tuesday, December 1

Forenoon Session—9:30 to 12:00

W. C. Harrington, chairman, presiding

1. REPORT: Committee on Farm House Standards and Designs, by D. G. Carter, chairman
2. REPORT: Committee on Dairy Barn Standards, by J. L. Strahan, chairman
3. REPORT: Committee on Grain Storage, by R. H. Black, chairman
4. REPORT: Committee on Fire Prevention and Protection, by E. G. Lantz, chairman

Afternoon Session—2:00 to 4:30

W. C. Harrington, chairman, presiding

1. REPORT: Committee on Standardization of Building Plans, by S. P. Lyle, chairman
2. REPORT: Committee on Design of Animal Shelters, by W. G. Ward, chairman
3. PAPER: "Prevention of Wind and Fire Losses to Farm Buildings," by E. D. Anderson, agricultural engineer, Iowa State College

Evening Session—7:30 to 10:00

Committee and Group Round Tables (by arrangement)

Second Day — Wednesday, December 2

Morning Session—9:30 to 12:00

Henry Giese, vice-chairman, presiding

1. PAPER: "Air Movements in Ventilated Structures," by F. L. Fairbanks, agricultural engineer, Cornell University
2. PAPER: "The Structural Application of Lumber to Farm Buildings," by Frank P. Cartwright, chief engineer, National Lumber Manufacturers Association
3. PAPER: "Recent Developments in Zinc Coatings of Sheet Steel for Structural Uses," by Geo. C. Bartells, field representative, American Zinc Institute

Afternoon Session—2:00 to 4:30

Henry Giese, vice-chairman, presiding

1. PAPER: "Design of Gambrel Roof Barns with Respect to Wind Loads," by F. C. Fenton, Kansas State College
2. PAPER: "Farm House Planning," by W. A. Foster, agricultural engineer, University of Illinois
3. PAPER: "The Preparation and Distribution of Plans for Farm Buildings," by W. D. Brinckloe, architect
4. PAPER: "Basic Information Needed for the Proper Ventilation of Poultry Houses," by Dr. H. H. Mitchell, department of animal husbandry, University of Illinois

Tentative Program

A.S.A.E. LAND RECLAMATION DIVISION MEETING

The Stevens Hotel, Chicago, Illinois
December 2 and 3, 1931

First Day — Wednesday, December 2

Forenoon Session—9:30 to 12:00

1. PAPER: "Profit as the Measuring Stick of Reclamation Projects, with Special Reference to Reducing Costs" (Speaker to be selected)
2. PAPER: "Indirect Benefits of Reclamation Projects," by W. A. Hutchinson, irrigation economist, Bureau of Agricultural Engineering, U. S. Department of Agriculture
3. PAPER: "Rehabilitation of Reclamation Projects Now in Difficulty" (Speaker to be selected)
4. PAPER: "Methods of Supplementing the Water Shortage on Irrigation Projects," by Geo. D. Clyde, associate professor of irrigation and drainage, Utah Agricultural College
5. PAPER: "Pumping for Drainage in the Upper Mississippi Valley," by J. G. Sutton, Bureau of Agricultural Engineering, U. S. Department of Agriculture

Afternoon Session—2:00 to 4:30

SYMPOSIUM: "The Drought Menace"

1. "Water Requirements for Various Yields of Major Cash and Feed Crops in Different Geographical Sections" (Speaker to be selected)
2. "Probable Frequency of Such Nation-Wide Droughts as that of 1930 and 1931" (Speaker to be selected)
3. "Frequency of Disastrous Regional Droughts in Semi-Arid Regions," by M. L. Wilson, professor of agricultural economics, University of Montana
4. "Frequency of Disastrous Regional Droughts in the Northern Mississippi Valley States," by H. B. Roe, agricultural engineer, University of Minnesota
5. "Frequency of Disastrous Regional Droughts in the Southern Mississippi Valley States," by Dan Scoates, agricultural engineer, A.& M. College of Texas
6. "Frequency of Disastrous Regional Droughts in the Atlantic Coast Region" (Speaker to be selected)
7. "Frequency of Disastrous Regional Droughts in the Pacific Coast Region" (Speaker to be selected)

Second Day — Thursday, December 3

Forenoon Session—9:30 to 12:00

SYMPOSIUM: "Methods of Protecting Crops Against Drought in Humid and Semi-Arid Regions"

1. "Irrigation as Stand-by Crop Insurance During Drought Seasons and Dry Spells in Normal Seasons in Humid Regions" (Speaker to be selected)
2. "Storage of Water Under Ground for Use in Times of Drought" (Speaker to be selected)
3. "Terraces to Conserve Surface Runoff" (Speaker to be selected)
4. "Planting of Cultivated Row Crops on Contour Lines as a Protection Against Drought Damage by Conserving Runoff" (Speaker to be selected)
5. "Underdrainage of Clay Soils and Subsoils as a Protection Against Crop Damage from Drought by Giving Roots Access to Greater Reservoirs, Storing More Rainfall in Subsoil, etc." (Speaker to be selected)

Afternoon Session—2:00 to 4:30

SYMPOSIUM: "Latest Aspects of the Control of Soil Erosion by Engineering Processes"

1. "Soil-Sampling Device for Measuring Soil Losses from Terraced Areas," by C. E. Ramser, senior drainage engineer, U. S. Department of Agriculture
2. "Operation of Farm Machinery Over Terraced Land" (Speaker to be selected)
3. "The Control of Soil Erosion in Illinois," by E. W. Lehmann, agricultural engineer, University of Illinois
4. "The Use of County Equipment for Erosion Control as Permitted by Texas and Oklahoma Laws," by A. K. Short, conservation and terracing agent, Federal Land Bank of Houston

Clemson Sponsors Farm Machinery School

A FARM machinery school for county agricultural agents was held near Columbia, South Carolina, November 2 to 6. It was arranged by J. T. McAlister, state extension agricultural engineer. The object of the school was to give the agents an opportunity to become familiar with the operation of machinery that can be profitably used on South Carolina farms.

Three well known agricultural engineers were on the program. George

R. Boyd, of the U.S.D.A. Bureau of Agricultural Engineering, addressed the agents on "Re-arrangement of Farms for the Efficient Use of Machinery." S. P. Lyle, senior agricultural engineer in the U.S.D.A. Extension Service, presented the subject "Fitting Farm Machinery into the County Agent's Program of Work." "The Influence of Farm Machinery Upon America," was the title of the address by F. A. Wirt, of the J. I. Case Company.

Throughout the five-day program the mornings and afternoons were devoted to practical field instruction and demonstrations and talks were given during the lunch hour and evening sessions.

A.S.H.V.E. Publish Booklet on Research

THE American Society of Heating and Ventilating Engineers has recently published a booklet "Research, Its Value to the Art and Industry of Heating, Ventilating, Air Conditioning," explaining the purpose and activities of its research laboratory.

This organization claims to be the only professional engineering society which maintains its own laboratory and allots a large share of its membership dues to research.

Combine Inventor Honored

UNDER the auspices of the Battle Creek Centennial and the Michigan State Historical Society a boulder and tablet commemorating Hiram Moore and his first combine was dedicated near Climax, Michigan, October 3, with appropriate ceremonies.

About 200 people journeyed out to the place, ten miles southwest of Battle Creek, for the services, which officially opened the Battle Creek Centennial celebration. A model of the original machine and a section of the original sickle bar were on display. H. H. Musselman, head of the department of agricultural engineering at Michigan State College, gave one of the dedicatory addresses. The tablet reads:

> "In the adjoining field on the 12th day of July, 1838, with 20 horses hitched to a newly invented machine that cut a swath 15 feet wide, Hiram Moore cut, threshed, separated, cleaned and sacked 30 acres of wheat that yielded 1,100 bushels. This was accomplished in one day's work with two teams and wagons following the "Combine" to carry the wheat to the log granary.
>
> "Hiram Moore settled on this farm in 1831, after he and Daniel Eldred had given the name of 'Climax' to this fine prairie and village. That summer Moore, at John Hascall's suggestion, commenced experimenting on and with a machine to take the place of the grain cradle. Moore was financially aided by Hascall and Lucius Lyon and a patent on the machine as a whole was secured in 1836. Moore was nearly 100 years ahead of the modern combine. His patent rights expired after 14 years and Michigan's Governor and the State Legislature fought with Congress and the U. S. Patent Office for a renewal of the patent for the inventor. Moore lost in the battle. He later left this farm and settled in Wisconsin.
>
> "Hiram Moore was a great inventor and an honored citizen of Michigan. He was born July 19, 1801, and died May 5, 1875."

Dedicate New Agricultural Engineering Building

THE new agricultural engineering building at the University of Kentucky Agricultural Experiment Station Farm was dedicated with appropriate services on the afternoon of October 28.

Frank L. McVey, president of the University of Kentucky, presided. Following the invocation, two former presidents of the A.S.A.E. delivered the dedicatory addresses. Dr. J. B. Davidson, head of the department of agricultural engineering at Iowa State College, presented the "Development of Agricultural Engineering." S. H. McCrory, Chief of the Bureau of Agricultural Engineering, U.S.D.A., had for his subject, "Contributions of Agricultural Engineering to Rural Life."

Dedication and the benediction completed the exercises. There was a display of both ancient and modern farm equipment in the building.

This new home of the University's agricultural engineering department occupies a prominent position at one end of a new agricultural quadrangle being developed on part of the campus included in the experimental station farm. The building itself conforms in general to a unified architecture and construction now being used in all new buildings on the campus. It is a U-shaped structure measuring 198 feet across the front and 98 feet deep. The front section includes two stories and a basement. The wings are one-story high. Between the wings is an open court measuring 70x90 feet and having a macadamized surface. It will be used for machinery demonstrations.

The New Agricultural Engineering Building at the University of Kentucky

Robb Elected Chairman of North Atlantic Section

B. B. ROBB, professor of agricultural engineering, Cornell University, was elected chairman of the North Atlantic Section of A.S.A.E. at its annual business session during the recent meeting of the Section at New Brunswick.

Other officers elected were L. G. Heimpel, vice-chairman; G. A. Rietz, secretary-treasurer; Ray W. Carpenter, O. B. Stichter and C. E. Seitz, nominating committee.

L. S. Caple, chairman of the Section for the year just past, presided at the New Brunswick gathering. Committee reports were also presented during the business session. Invitations for the 1932 meeting to be held at Albany, New York City, Old Point Comfort, Montreal and Toronto were read, discussed and left to the discretion of the executive committee.

The two and one-half days of technical sessions followed the program announced and were well attended.

Indiana Holds Fifth Annual Rural Electric Conference

FOR the fifth successive year the Purdue University Agricultural Experiment Station, in cooperation with the Indiana Electric Light Association, is holding a conference on rural electrification, primarily for the information and training of rural electric service men in the state.

The conference this year is scheduled for the three days of November 12, 13 and 14. A.S.A.E. members on the program are C. V. Sorensen, Richard Boonstra, Wm. Aitkenhead, I. P. Blauser, H. J. Gallagher and W. T. McCaskey. Leading spirit in organizing and arranging the conference is Truman E. Hienton, project leader in rural electrification, Purdue University.

Exhibits of latest rural electric equipment on display in the new agricultural engineering building will be another feature of the conference.

American Engineering Council

A PROGRAM of unemployment relief particularly applicable to employment in work which comes under the direction of engineers, has been announced by Council. The entire engineering profession is urged

to cooperate in the work, which will follow recommendations made in a report of Council's Committee on Relief from Unemployment. F. J. Chesterman is chairman of that committee. The report was approved by Council's Executive Committee in August. It also has the approval of the President's Organization on Employment, the work of which it supplements.

Council is urging each of its member societies to appoint the necessary committee or committees to accomplish the recommended program. The points in the program are as follows:

1. Bring forcibly to the attention of each engineer within the sphere of its influence the constructive assistance he may render by carefully studying the business with which he is associated from the point of view of what may be done to spread employment during this period of depression and particularly towards developing a sound, practicable plan for permanently stabilizing employment in the business with which he is connected.

2. Stimulate the individual engineers to confer with and endeavor to get their respective employers to inaugurate a line of endeavor as indicated in item one above.

3. Have the individual engineer join with his associates in a given enterprise to collect data regarding any methods used in their company for stabilizing employment, both as to:

a. Emergency employment
b. Permanent stabilization of employment

4. The Society, through committees, assemble the information produced through the activities suggested in items 1 to 3 inclusive above, and when properly analyzed disseminate the information as broadly as possible. It is important to acquaint the public with the facts that some industrial and commercial leaders are aggressively active, that they recognize the problem and are endeavoring to solve it. Publicity is also important as a means of stimulating those industrial and commercial leaders who have done nothing to do something, and furthermore, by example suggest what they may do.

The public educational work contemplated may be made very beneficial. Especially will it be needed to encourage and stimulate the small plant or business. The small industrial and commercial units are the ones which will need and require the greatest assistance and stimulation. The large units as Proctor and Gamble, General Electric, and others, have and will develop plans of stabilizing employment. Therefore the real crux of the situation is to energize the mass in a large measure composed of small industrial and business establishments. With these the engineering profession can be most effective.

Some employers will hesitate to permit publicity about their activities. They should be persuaded to permit publicity for the good of the community and the economic well-being of the nation.

5. Devote the necessary number of meetings of the Society to the subject so as to secure a thorough discussion of successful plans for stabilizing employment. Such meetings will afford local employers an opportunity to present to the public their respective plans and the results.

6. At all times endeavor to secure adequate local publicity for the discussions, plans in operation and any resolutions passed by the Society on the subject. Demonstrate to the community the value of stabilized employment and the part the engineer can and is playing in bringing about a sounder economic structure.

7. Investigate and extend aid to worthy employment relief plans. Cooperate fully with all local agencies concerned. Coordinate insofar as possible all activities relating to employment. By all means coordinate the activity of the engineering and allied technical groups of your area.

8. Since the entire program is largely one of sane education, the educational institutions should be enlisted in every practicable manner. It may be advisable to have some general conferences which could be held under the auspices of the local educational institutions. Addresses by professors and others as to what has been accomplished in stabilizing employment would be beneficial.

9. Carefully study and take some positive position on any proposed state legislation or city ordinance relating to employment.

10. While this program is designed for local application, it is desired that the net results be national in scope. It is earnestly desired that the engineering profession, working through local units, may give direction to a line of thinking and action which will result in a national solution of the grave problem of unemployment. For this reason it is earnestly requested that each organization keep American Engineering Council informed of the progress of its work and especially of any unusual results effected or plans revealed.

The objectives of this program are stimulation of individuals to appropriate action, unity of action, coordination, education and encouragement, and cooperation. It is recognized that there is a pronounced feeling that industry and commerce are largely responsible for unemployment and that unless they take active steps to improve the situation, it will be made a political football. Leading engineers are also confident that the situation can be more nearly corrected by the managements of industrial and commercial enterprises than by the unemployment insurance which apparently would be the form of political corrective measures.

ASAE Meetings

Power and Machinery Division — at the Stevens Hotel, Chicago, Ill., Monday and Tuesday, November 30 and December 1.

Structures Division—at the Stevens Hotel, Chicago, Ill., Tuesday and Wednesday, December 1 and 2.

Reclamation Division — at the Stevens Hotel, Chicago, Ill., Wednesday and Thursday, December 2 and 3 (Tentative).

Southern Section — at Birmingham, Alabama, February 3, 4 and 5, 1932.

Twenty-Sixth Annual Meeting — at Columbus, Ohio, Monday, June 20, to Thursday, June 23, 1932, inclusive.

New ASAE Members

Carl A. Arneson, assistant sales manager, Delaware Friend Corporation, Gasport, N. Y.

Hugh A. Brown, director of reclamation economics, Bureau of Reclamation, Department of the Interior, Washington, D. C.

John R. Carreker, rural electrification sales, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

Orval C. French, junior agricultural engineer, University of California, Davis, Calif.

Edwin H. Sudduth, Jr., engineer and assistant to the president, W. B. Swain, Inc., Hollyknowe, Miss.

Francis D. Yung, assistant to research engineer, University of Nebraska, Lincoln, Nebr.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the October issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Lawrence J. Denmire, assistant manager of farm and cannery, L. E. Denmire, R.F.D. No. 1, Montrose, Ia.

James Simon Jacobs, agricultural mechanics instructor, Union High school, Lancaster, Calif.

William S. Lynes, travelling salesman, Mason City Brick & Tile Company, L.B. No. 71, Waverly, Ia.

Dale E. Springer, Garrison, Kans.

Herbert N. Stapleton, instructor, department of agricultural engineering, Pennsylvania State College, State College, Pa.

Transfer of Grade

Edward D. Gordon, associate agricultural engineer, Bureau of Agricultural Engineering, Department of Agriculture, Iberia Livestock Experiment Farm, Jeanerette, La. (Junior to Member)

J. Dewey Long, assistant professor and assistant agricultural engineer, University of California, Davis, Calif. (Associate to Member)

EMPLOYMENT BULLETIN

An employment service is conducted by the American Society of Agricultural Engineers for the special benefit of its members. Only Society members in good standing are privileged to insert notices in the "Men Available" section of this bulletin, and to apply for positions advertised in the "Positions Open" section. Non-members as well as members, seeking men to fill positions, for which members of the Society would be logical candidates, are privileged to insert notices in the "Positions Open" section and to be referred to persons listed in the "Men Available" section. Notices in both the "Men Available" and "Positions Open" sections will be inserted for one month only and will thereafter be discontinued, unless additional insertions are requested. Copy for notices must be received at the headquarters of the Society not later than the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. There is no charge for this service.

Men Available

AGRICULTURAL ENGINEER - SALES EXECUTIVE, eleven years' experience with large tractor and implement company, open to connection with manufacturer, domestic or foreign, or in farm management. Age 38. Family. MA-205.

GRADUATE MECHANICAL ENGINEER, with fifteen years' experience in the engineering and sale of parts and accessories to farm machinery, tractor and industrial manufacturers, desires a new connection. Married. MA-206.

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